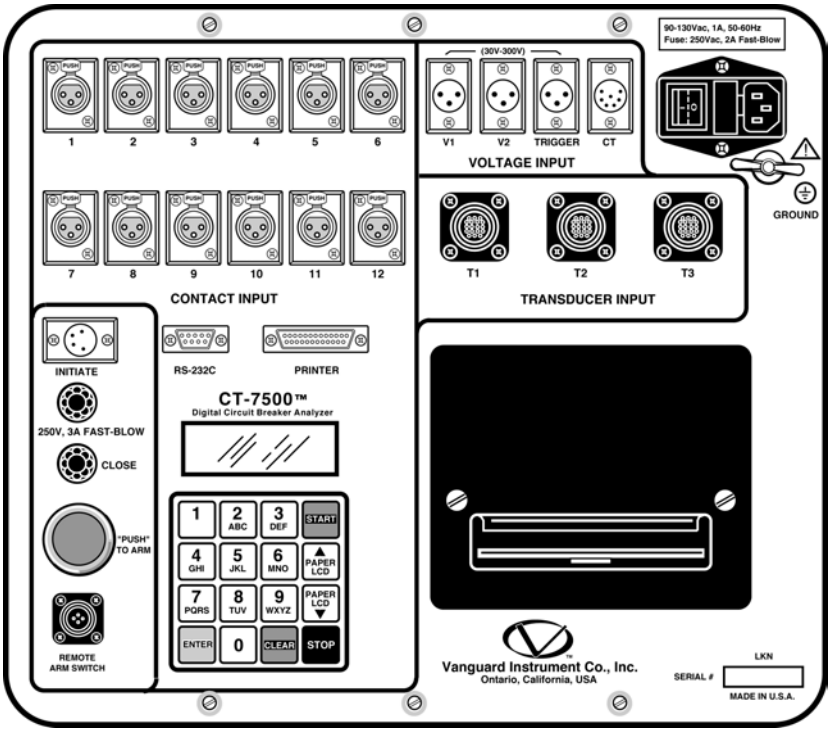
OPERATING INSTRUCTIONS
For the
Model CT-7500
A Digital Circuit-Breaker Analyzer



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1.0 Introduction

The Model CT-7500 is a microprocessor-based digital time-versus-travel Circuit Breaker Analyzer with a special on line test mode. This on line test mode (Quick-Shot mode) allows the user to capture breaker contact close time and contact open (clear) time while the breaker is still in service. In the off line test, the Model CT-7500 fully analyzes utility circuit-breaker performance: contact time, stroke, velocity, over-travel, bounce-back, and contact wipe.

Contact-motion analysis includes: Open, Close, Open-Close, Close-Open, and Open-Close-Open. A timing window is selectable between 1-second or 10-second periods. The 10-second window allows timing of long events (e.g., circuit switcher contacts).

The CT-7500 is available in three models:

- CT-7500-3; three contact channels.
- CT-7500-6; six contact channels.
- CT-7500-12; twelve contact channels.

All the CT-7500 models have the following input:

- Three Digital Travel Transducer Input channels.
- One Analog Voltage Monitor Input channel.
- One Digital Voltage Monitor Input channel.
- One Trip/Close current monitor channel.

There are two modes of operation for the CT-7500: Stand Alone Mode and Computer Control Mode. This manual will focus on the CT-7500 Stand Alone Mode. The Computer Control Mode is covered under the CT-7500 PC software manual.

2.0 CT-7500 Description

2.1 On-line Timing (Quick-Shot) mode

A clamp-on AC current probe connected to the breaker bushing CT lets the CT-7500 measure breaker switching time (while the breaker's still in service). The CT-7500 can time an OPEN operation by sensing the time when the OPEN coil is energized until the bushing CT current returns to zero. CLOSE time is detected when the close coil is energized until the bushing CT current is detected.

This "Quick-Shot" mode provides a quick way to diagnose breaker performance and savings in maintenance cost.

2.2 Time-Versus-Travel Circuit Breaker Analyzer Mode

The CT-7500 applies a 35Vdc voltage to each of the contact channels. This test voltage is sensed by an analog to digital converter (A/D) to determine the state of the contact (close, or open, or insertion resistor). The CT-7500 records the A/D reading at a 10 KHz rate, and stores these readings in memory. The contact/resistor time is then derived from data stored in memory.

The CT-7500 uses three up-down counters to sense the breaker's transducer reading. The CT-7500 travel transducer employs an optical encoder to send quadrature signals to the CT-7500's counters. With the use of the digital transducer and counters, the user never has to set up

or calibrate the transducer.

The CT-7500 has a built-in initiate circuit to operate circuit breakers. Since this solid-state circuit is controlled by the micro-processor, the CT-7500 can perform multiple operations (O-C, C-O, O-C-O) with ease. Each Trip and Close initiate circuit is fuse protected. The user is also required to hold the "ARM" switch during a test to complete the initiate circuit.

The CT-7500 can also store up to 200 breaker-timing test records and 45 breaker test-plans in FLASH EEPROM. Stored timing test records can be recalled and printed or transferred to the PC. Using the breaker test plan during a test, the users do not have to set the velocity calculating points. The CT-7500 will also print "PASS" and "FAIL" results on test report.

2.2.1 Contact Timing Channels

A breaker's interruption of contacts is timed with the dry-contact input channels. Each channel can detect the main contacts and insertion resistor contacts times (in millisecond and cycles).

Note

The CT-7500 can detect insertion resistors in a 10-7000 ohm range. Resistances over 7000 ohms are detected as an open contact.

2.2.2 Analog Voltage Monitoring Channel

An analog voltage input is dedicated to monitoring a breaker's dc power supply or coil voltages (0-255 V dc or peak ac).

Note

Input voltage range is 0-300Vdc or peak AC. Reading range is 0-255Vdc.

2.2.3 Digital Voltage Monitoring Channel

One digital voltage input channel monitors voltage on/off status. Voltage threshold from 30-255 Vdc is considered as "ON" status. Voltage threshold less than 30 Vdc is considered as "OFF" status.

2.2.4 Trip/Close Current Monitoring

A built-in Hall-effect sensor records Trip and Close coil current levels and duration. The breaker's operate coil current waveform is graphically plotted on a printout. Current reading is also printed in the tabulated report.

2.2.5 Travel Transducer Input Channels

Each CT-7500 has 3 digital transducer input channels. These transducer channels require neither setup nor calibration.

2.2.6 Breaker Initiate Capability

A built-in solid-state initiate device lets users operate a breaker from the CT-7500. Operational modes include: Open, Close, Open-Close, Close-Open, Open-Close-Open. Multiple operations

(e.g., Open-Close, Close-Open, Open-Close-Open) can be initiated with a programmable delay time or by sensing the breaker's contact state.

Because solid-state switching is used in the initiate circuitry, the CT-7500 can switch a breaker's ac or dc control circuit. Each trip and close circuit is protected by a 3-ampere fuse. The initiate circuit is also protected by an interlock "ARM" switch.

2.2.7 Built-in Thermal Printer

A 4.5-inch wide thermal printer prints the breaker's contact analysis results in both tabular and graphic formats.

2.2.8 Printer Port

A parallel printer port can drive a H-P color ink-jet printer, from which a color graphic of timing charts and tabulated results can be printed on 8½-11-inch paper.

An Ink-Jet printer is supplied with each CT-7500.

2.2.9 Computer Interface Capabilities

A built-in RS-232C port lets timing shots stored in CT-7500 EEPROMs to be down-loaded to an IBM-compatible PC. Windows-based (Windows 95, Windows 98, Windows Me, Windows 2000, and Windows NT) Breaker Analysis Software is supplied with the CT-7500. This software allows the user to:

- Time Circuit breakers from a PC.
- Retrieve timing shots stored in CT-7500.
- Recall timing shots from a hard drive for re-analysis (at an office PC).
- Create breaker test plans on a PC and load into the CT-7500.

2.2.10 Timing Shots Storage Capabilities

The CT-7500 uses Electrical Erasable PROMs (EEPROM) to store timing-shot data. Unlike other media, EEPROMs are immune to temperature, shock, and humidity. Stored shots can be recalled to reanalyze test data, to re-print test reports, or transfer data to an IBM compatible PC for record keeping. Up to 200 timing shots can be stored in the EEPROMs. The number of shots stored in EEPROMs can vary, depending on the size of the shot records.

2.2.11 Breaker Test Plan Storage Abilities

Up to 45 breaker's test plans can be stored in the CT-7500. Test plans comprise breaker specifications (i.e., stroke, velocity, contact time). By recalling and using a test plan, operators can immediately test breakers and view a pass/fail report (made by comparing test performance with specifications in the test plan). Breaker specifications need not be referenced to compare test results to determine if a breaker passed.

A breaker test plan can be created by using the Breaker Analysis Software (supplied with each CT-7500). The test plan is then loaded into the CT-7500 via an RS-232C serial port.

2.2.12 Diagnostic Capabilities

The CT-7500 can run diagnostics on its own electronics. Self-testing of contact cable hook-ups and transducers lets users checkout CT-7500 accessories whenever verification is required.

2.2.13 CT-7500 Display and Control Switches

An alpha-numeric keypad lets the user enter breaker's name plate data (Substation name, Breaker Model, etc) and control function. A 4-line by 20-character LCD readout displays user messages. The LCD is back lighted so messages can be viewed in low light levels.

3.0 Test Result Tabulation

3.1 Electrical Measurement Results

Each CT-7500 contact channel provides the following test results:

- Contact Close time, (Quick-Shot) Mode.
- Contact Open (Clear) time, (Quick-Shot) Mode.
- Main contact and insertion resistor contact times (Time-Travel Test).
- Contact bounce time (Time-Travel Test).
- Contact spread time (Time-Travel Test).

NOTE

The CT-7500 can detect insertion resistors in a 10-7000 ohm range. Resistances over 7000 ohms are detected as an open contact.

3.2 Mechanical Measurement Results

Each digital transducer channel provides the following test results:

- Breaker stroke (Time-Travel Test).
- Over travel (Time-Travel Test).
- Bounce back (Time-Travel Test).
- Contact wipe (Time-Travel Test).
- Velocity (Time-Travel Test).

Breaker contact speed calculation is based on a contact's travel distance over a period of time, which is defined by the manufacturer's specifications.

A CT-7500 not only calculates simple distance-over-time speeds, but can also support other formulas. An example is Siemen TCP breaker calculation formula:

$$V=12.2 \times a/b$$

The formula and analysis points can be stored in a test plan for use later in the field.

NOTE

If operators use a breaker test plan (see paragraph 9.8) during testing, the test report will also indicate a Pass/Fail condition for each test parameter (i.e. contact time, stroke, velocity, etc.).

3.3 Analog Voltage Input Results

The analog voltage input channel (V1) measures the breaker's dc control voltage during operation. Printed voltage readings include nominal voltage (supply voltage at no load) and minimum voltage (supply voltage under load or when a coil is energized).

This connection allows the user to monitor the DC power supply voltage fluctuation during breaker's operation. This feature is handy to detect breaker's power supply problem; which

normally can not be seen using a volt meter.

NOTE
Voltage reading range is 1.0-255 V dc.

3.4 Digital Voltage Input Results

The Digital Voltage Input channel (V2) monitors voltage on/off conditions and graphs the result. A voltage level above 30Vdc is considered as "ON" condition. This input channel is dedicated to monitor breaker's auxiliary switch action during breaker's operation.

NOTE
Input voltage range is 1.0-300 V ac/dc.

3.5 Initiate Current Results

The CT-7500 not only plots Trip or Close current waveforms, but also prints steady-state current readings of trip and close coils during operation.

NOTE

1. If the CT-7500 initiates the OPEN test or CLOSE test under the Quick-Shot test, the test report will show OPEN or CLOSE coil current reading and current wave form.

2. If the user operates the breaker for the Quick-Shot test (external trigger), no coil current reading or waveform will be recorded.

3.6 Slow-Close Test

A slow-close test finds the contact touch distance and penetration by using the travel transducer and dry contact channels.

4.0 Test-Results Graphics

4.1 Thermal Printer Graphic Printout

A 4.5" wide built-in thermal printer prints graphic waveforms of contact channels, travel curves, and actuator-coil currents. With a zoom graphics mode, the user can select an enlargement by specifying the timing zone.

4.2 Ink-Jet Printer Output

A color graphic report can be printed on the HP Ink-jet printer (supplied with each CT-7500). The CT-7500 will print color graphics of contact channels, travel channels, current waveforms on 8½- by 11-inch paper.

5.0 Controls and Display

(See Figure 5-1 and Table 5-1.)

Before using the CT-7500 Analyzer, users should become familiar with all of its controls and display indications. The keypad and display are used to operate the CT-7500 Analyzer. Figure 5-1 shows the control panel and numbered lines pointing to each control and indicator. The line numbers refer to Table 5-1, which describes the function of each control and indication.

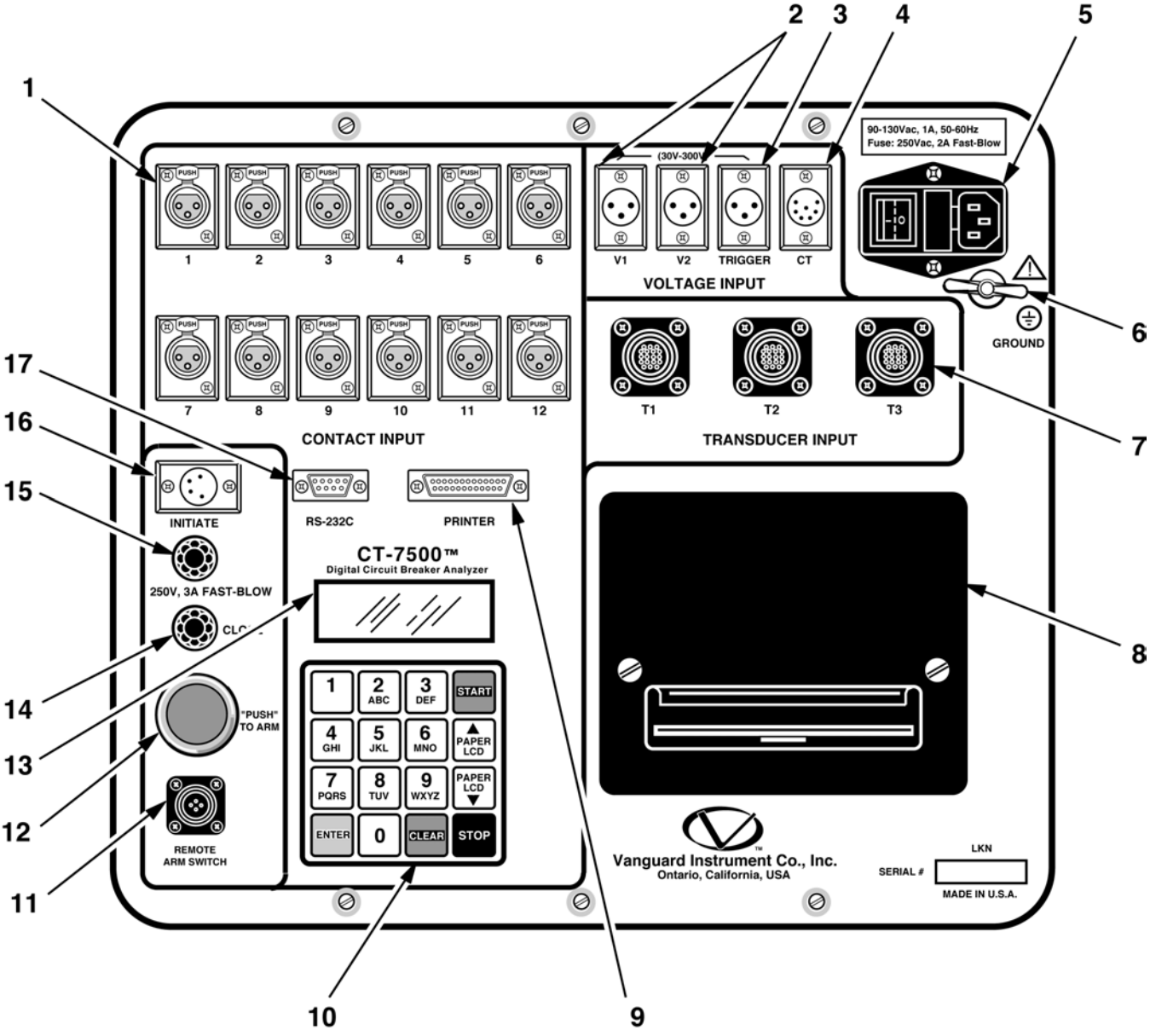


Figure 5-1. CT-7500 Control Panel

Table 5-1. Model CT-7500 Controls and Displays

Fig. 5-1 Index no.	PANEL MARKING	FUNCTIONAL DESCRIPTION
1	CONTACT INPUT (1-12)	Connector, 3-pin: each input is a continuity (dry) sensor for detecting a contact closing or opening (a timing input to the processor).
2	(30V-300V) VOLTAGE V1 & V2/ VOLTAGE INPUT	Connector, 3-pin: each input is a voltage detector for timing voltage (30-300 V dc/peak) of trip or close coil switching (active period).
3	TRIGGER/VOLTAGE INPUT	Connector, 3-pin: input (30-300 Vac, dc, or peak) triggers timing functions.
4	CT	AC current sensor input channel.
5	AC 100-240V; 5A MAX	Power plug (3-wire), ac fuse, ON/OFF switch: Switch is 2-pole rocker, input power on & off.
6	GROUND	Stud, 5/16-18 threads, with wing nut; safety ground terminal.
7	TRANSDUCER INPUT (T1, T2, T3)	Connector, 16-pin: each input (T1-T3) is a Travel Encoder output (contact motion data).
8	(Printer; No panel marking)	Thermal printer; prints on specially treated 4½-inch wide paper; processor controlled.
9	PRINTER	Printer port connector, 25-pin.
10	1-9, 0, ENTER, START, STOP, CLEAR, ↑ PAPER LCD, ↓ PAPER LCD	Keypad, 16-key; keys are momentary-contact pushbutton switches: makes menu selections, enters alpha-numeric data, adjusts LCD contrast, and moves paper.
11	REMOTE ARM SWITCH	Remote Arm Switch connector. The remote Arm switch with a 15ft cable is provided with each CT-7500.
12	"PUSH" TO ARM	Pushbutton switch, spring-loaded: press & hold to complete trip & close circuits for breaker tests.
13	(Display; no panel marking)	Liquid-Crystal Display (LCD), back lighted: 4-line by 20 characters per line: displays menus, options, prompts, and test-result data.
14	CLOSE/ 3 A	Close circuit fuse (3 amperes).
15	OPEN/ 3 A	Open circuit fuse (3 amperes).

Table 5-1. Model CT-7500 Controls and Displays (cont')

Fig. 5-1 Index no.	PANEL MARKING	FUNCTIONAL DESCRIPTION
16	INITIATE	Connector, 4-pin; switching circuit for operating the circuit breaker being tested.
17	RS-232C	Connector, 9-pin:RS-232C computer interface.

6.0 CT-7500 Analyzer Specifications (See table below.)

CONTACT TIMING	Open, Close, Open-Close, Close-Open, and Open-Close-Open
SIZE & WEIGHT	16d by 14w by 11h (inches); Less than 32 pounds
OPERATING POWER	3 amps, 90-120Vac/200-240Vac 50/60 Hz
AC CURRENT SENSOR	0-25 Ampere, non-contact AC current sensor
DRY-CONTACT INPUTS	3, 6, or 12 dry-input channels; Each detects Main & Insertion-Resistor contacts
TIMING WINDOW	Selectable: 1 second or 10 seconds
RESOLUTION	± 100 microseconds at 1-second duration; ±1.0 millisecond at 10-seconds duration
DRY-CONTACT CHANNEL PROTECTION	Fuses protect all isolated power supplies; All contact inputs are grounded until test; Inputs are MOV protected
CONTACT RESISTANCE	CLOSED: <20 ohms; OPEN: >10,000 ohms
INSERTION RESISTANCE	Range: 10 to 7,000 ohms
TRIGGER INPUT	Open/Close: 30 to 300 volts, dc or peak ac
VOLTAGE INPUTS	Two: 1.0-300 volts, dc/peak ac; analog voltage recording 1.0-255 V dc
CURRENT-SENSOR INPUT	One: Non-contact, Hall-Effect sensor, 0.2 to 25 amp ranges, dc to 5 kHz
BREAKER INITIATE	Initiate Open, Close, Open-Close, Close-Open, Open-Close-Open
TRAVEL TRANSDUCERS	3 travel-transducer channels; Linear motion: 0.0-60.0 (±0.01) inches; Rotary Range: 0-360^{o} (± 0.36$^{o)}$
CONTACT TRAVEL POINT DIFFERENCE	Measures"Slow-Close" contact point distance (Hard Copy)
BREAKER ANALYSIS SOFTWARE (included)	Analysis software runs on IBM-compatible. Software package for graphic display, numerical reports, and database utility for shop or office
COMPUTER INTERFACE	RS-232C Port
DISPLAY	Back-lighted LCD screen: 4 lines by 20 characters, sunlight viewable
HARD-COPY PRINTOUT	Contact travel waveforms & tabulated results print on 4.5-inch thermal paper
COLOR PRINTER	Built-in parallel printer port. CT-7500 produces both graphic and tabulated test results in color on 8.5 by 11 (inches) paper via external ink-jet printer
CARRYING CASE (optional)	Hard shipping case for both CT-7500 and Travel Transducer

WARRANTY	One year warranty on parts and labor; post-warranty service contracts available

7.0 CT-7500 Special Features

7.1 CT-7500 Operating Voltages

The CT-7500 operating voltage is selectable between 110/120 V, 50/60 Hz or 220/240 V, 50/60 Hz. Voltage selection is set by one jumper/connector on the Initiate PCB (JP3) and one jumper/connector on the Power Supply PCB (JP1). Jumper setting for both connectors is shown in table 7-1.

Table 7-1. Voltage Selection Jumper Setting

VOLTAGE SELECTION	CONNECTOR PIN
110/120 Vac	Pin 1& 2, 3 & 4
220/240 Vac	Pin 2 & 3

Note:
Operating voltage is set from the factory.

7.2 CT-7500 Main Power Fuse

The CT-7500 uses an AC input module containing the AC receptacle, Power switch, and Protective fuse. Replacement fuse should be: 20mm, 2A-250Vac slow blow.

7.3 CT-7500 Printer and Printer Paper

The CT-7500 built-in thermal printer uses 4.5-inch wide thermal paper for printing test results. To maintain the highest quality test-result printing and to avoid paper jamming, the use of paper supplied by our factory is highly recommended. Additional paper can be ordered from either of the two sources listed below:

Vanguard Instruments Co, Inc.
1710 Grevillea Court
Ontario, CA 91761
Tel: 909-923-9390
Fax: 909-923-9391
Part Number: TP-4 Paper
OR
BG Instrument Co.
13607 E. Trent Avenue
Spokane, WA 99216
Tel: 509-893-9881
Fax: 509-893-9803
Part Number: TP4 paper

7.4 CT-7500 Printer Paper Control

To advance paper from the printer, press and release the "↑ PAPER LCD" switch; to retract the paper from the printer, press and release "↓ PAPER LCD" switch.

7.5 Replacing CT-7500 Thermal Paper

The thermal paper roll is residing in the pocket under the printer cover. To replace the thermal paper roll, follow these steps:

- Remove printer cover.
- Remove leftover thermal paper roll from paper holder.
- Unroll new thermal paper roll.
- Feed thermal paper into the slot between the paper pocket and roller. The printer will pull paper under the thermal head.
- Roll thermal paper roll and place this paper roll in paper holder.
- Lift thermal head and align thermal paper if necessary.
- Reinstall printer cover.

Note

Thermal paper will show a red stripe to indicate “Close to End of Paper”.

7.6 CT-7500 LCD Contrast Control

To Darken the LCD display, press and hold the “↑ PAPER LCD” switch for two seconds; to lighten the LCD display, press and hold the “↓ PAPER LCD” switch for two seconds.

8.0 TEST HOOKUP CONNECTIONS

8.1 Contact Cable Hookup

A typical contact cable connection to a circuit breaker is shown in Figure 8-1.

NOTE

It is advisable to ground one side of the contacts for most testing. If a breaker is floating (i.e., ungrounded), ensure contact-channel inputs are protected against static discharge.

A typical series contact connection is shown in Figure 8-2.

8.2 Initiate Cable Hookup

A CT-7500 will trip or close breakers with a solid-state device, which will operate on any ac or dc control voltage from 10 to 300 volts. Both the trip and close circuits are protected by 3-ampere fuses.

A typical dc trip and dc close control circuit test hookup is shown in Figure 8-3.

A typical dc trip and ac close control circuit is shown in Figure 8-4.

8.3 Analog Voltage Monitor Hookup

The analog voltage input (V1) lets users monitor a breaker's dc-control voltage during operation. The analog voltage input (V1) will record the norminal dc voltage (at no load) and the minimum dc voltage (while the Trip or Close coil is energized).

Nominal and minimum voltage readings will print on a tabulated report. Analog waveform will also plot in a graphic report. This lets the user see the breaker's dc control voltage "dip" under load. Problems, such as a poor connection or an excessive voltage drop, during operation can thus be easily detected.

A typical voltage monitoring hook up is shown on Figure 8.5.

NOTE

Maximum voltage recorded is 255 Vdc.

8.4 Digital Voltage Monitor Hookup

The Digital V2 voltage input channel lets users monitor the voltage ON/OFF state. The voltage ON/OFF state will be plotted on the graphic report. A typical hook up is shown on Figure 8.5.

8.5 External Trigger Input

External trigger mode lets a user start a recording when the CT-7500 senses a voltage. A typical application for this external trigger mode is to time a circuit breaker in a close operation and to start timing only when the close coil is energized (bypassing the 52X relay delay time).

Since the 52X relay carries the close coil current, the user wants to connect the CT-7500's initiate cable to the close terminal (figure 8-4). The CT-7500 will energize the 52X relay to start the close operation. The CT-7500 then will start the timing when it senses the voltage across the closing coil. See Figure 8.6 for a typical test hookup.

Another application (for external trigger) is to start timing the breaker when the user trips or closes the breaker remotely.

NOTE

Minimum trigger voltage is set for 30 V ac/dc. Maximum continous voltage is 300Vac/dc. Different trigger voltages can be set at the factory, based on specific requests from users.

The CT-7500 will start looking for the external trigger input voltage after the CT-7500 Initiate Sequence is completed (CT-7500 stops beeping after the user presses “START” key) and message “LOOKING FOR TRIGGER VOLTAGE” is shown on LCD.

This external trigger voltage needs to be sensed by the CT-7500 within 5 second after the Initiate sequence. The CT-7500 will return to main menu if no voltage is sensed.

8.6 AC Current Sensor Hookup

A clamp-on AC current sensor connecting to the breaker bushing CT allows the CT-7500 to sense breaker bushing current. The AC current sensor requires a 100mA current to operate. Maximum current is 25 amperes. Typical hookup is shown on figure 8-8.

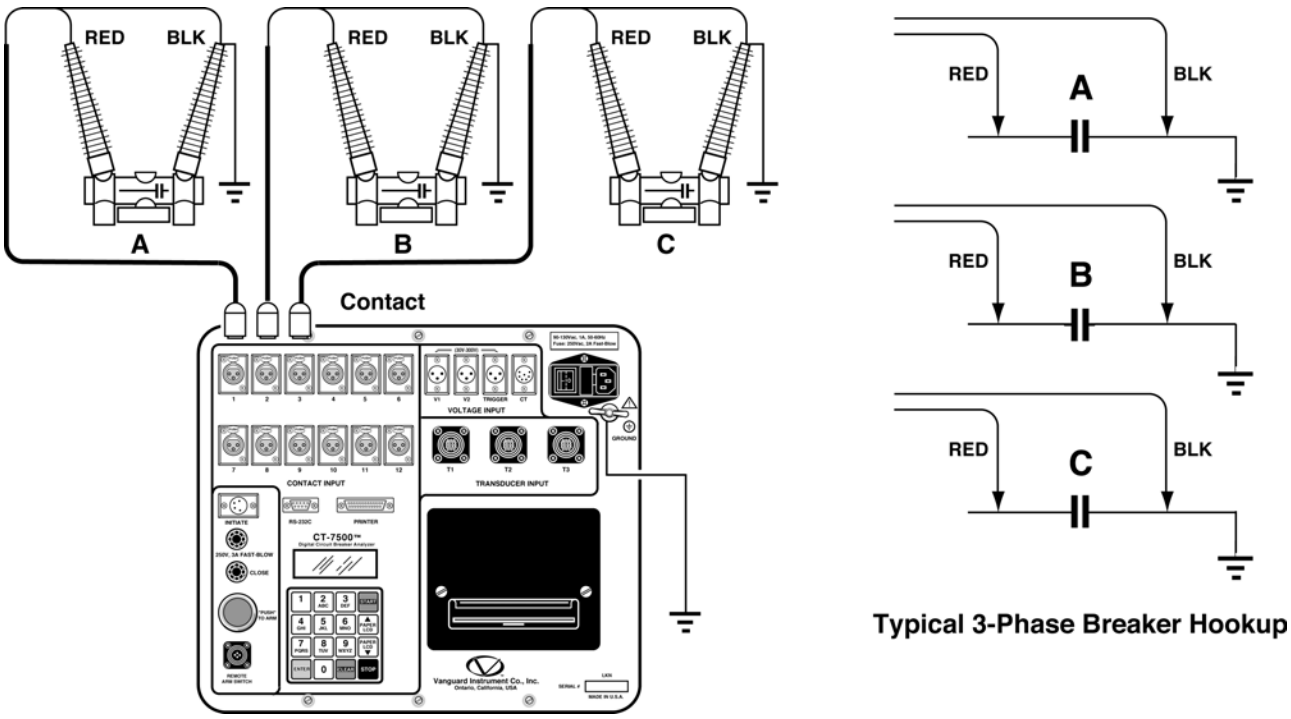


Figure 8-1. Typical Single Break Contact Cable Hookup

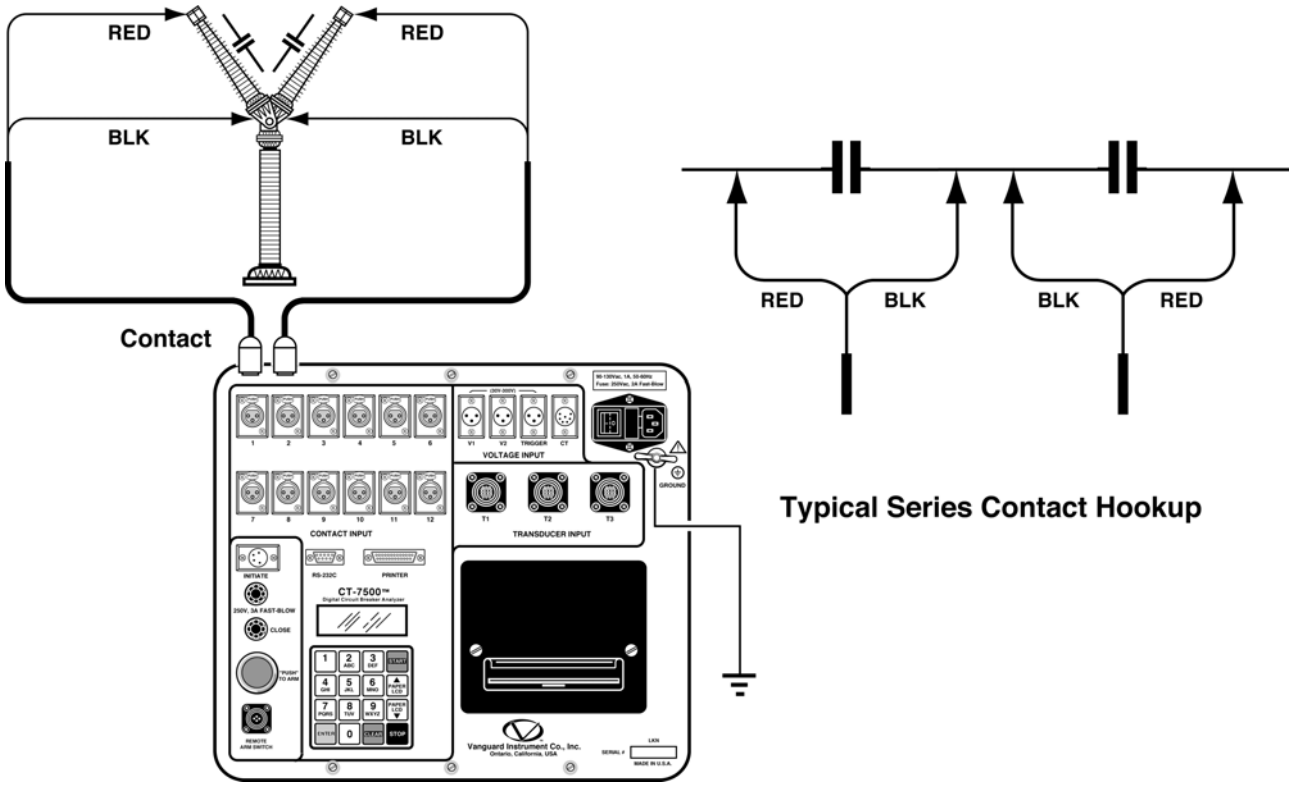
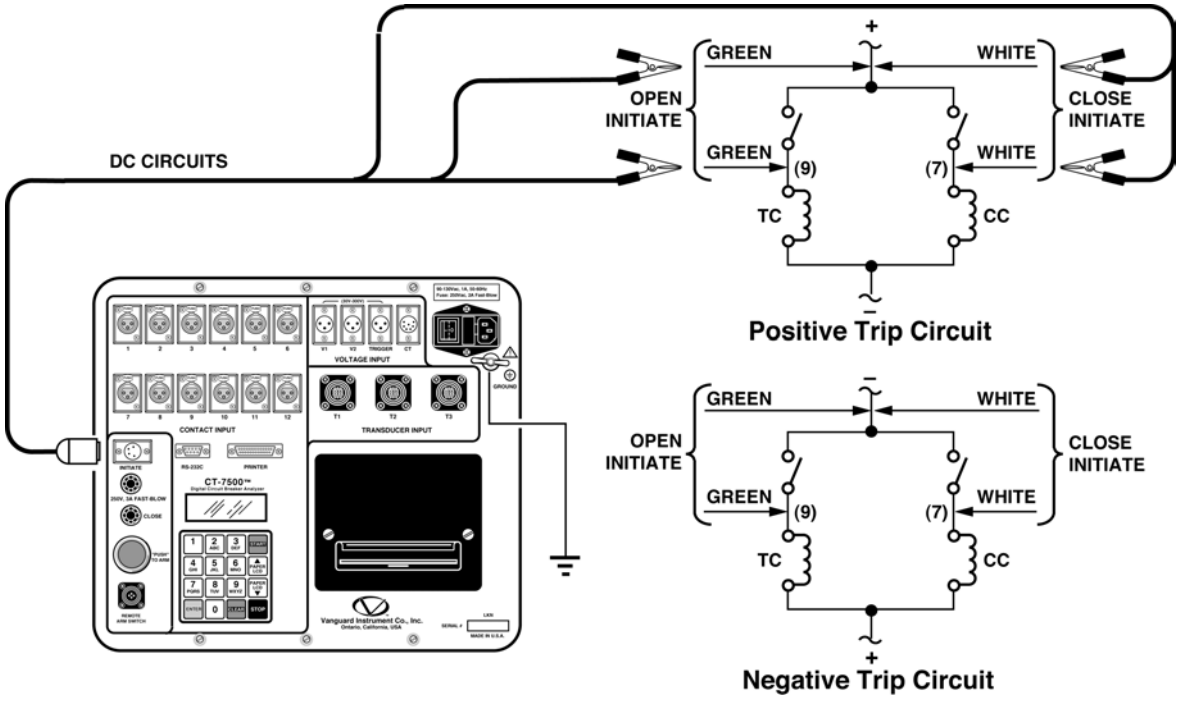


Figure 8-2. Typical Series Contacts Test Cable Hookup



Firgure 8-3. Typical DC Trip and Close Control Test Cable Hookup

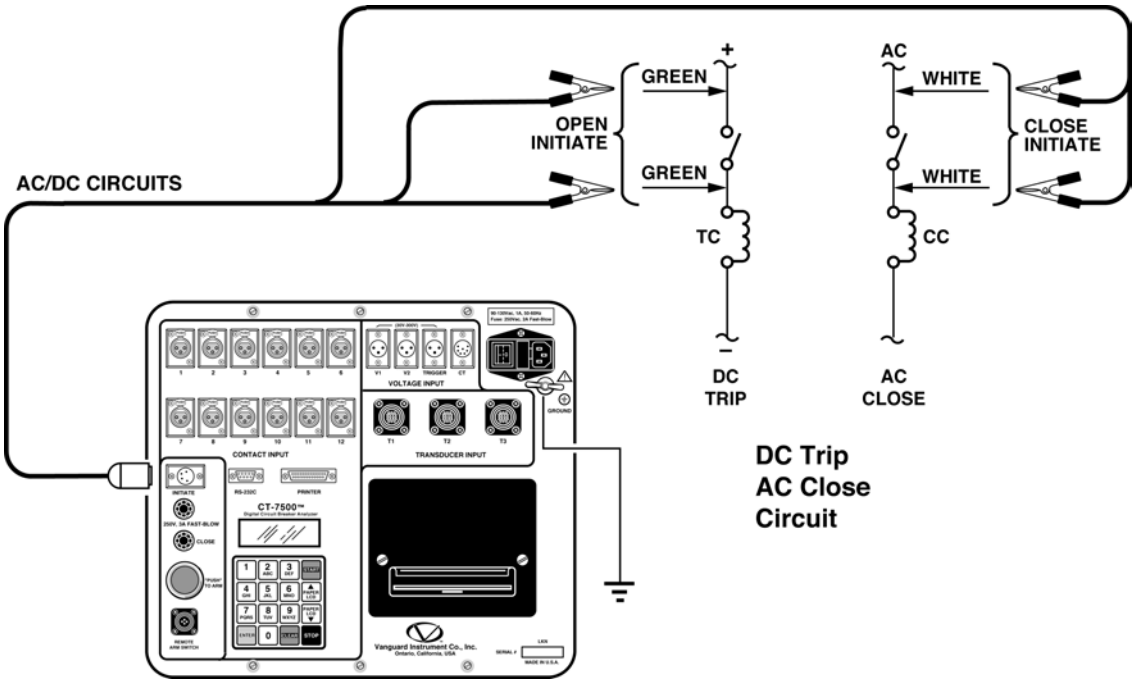


Figure 8-4. Typical DC Trip and AC Close Control Test Cable Hookup

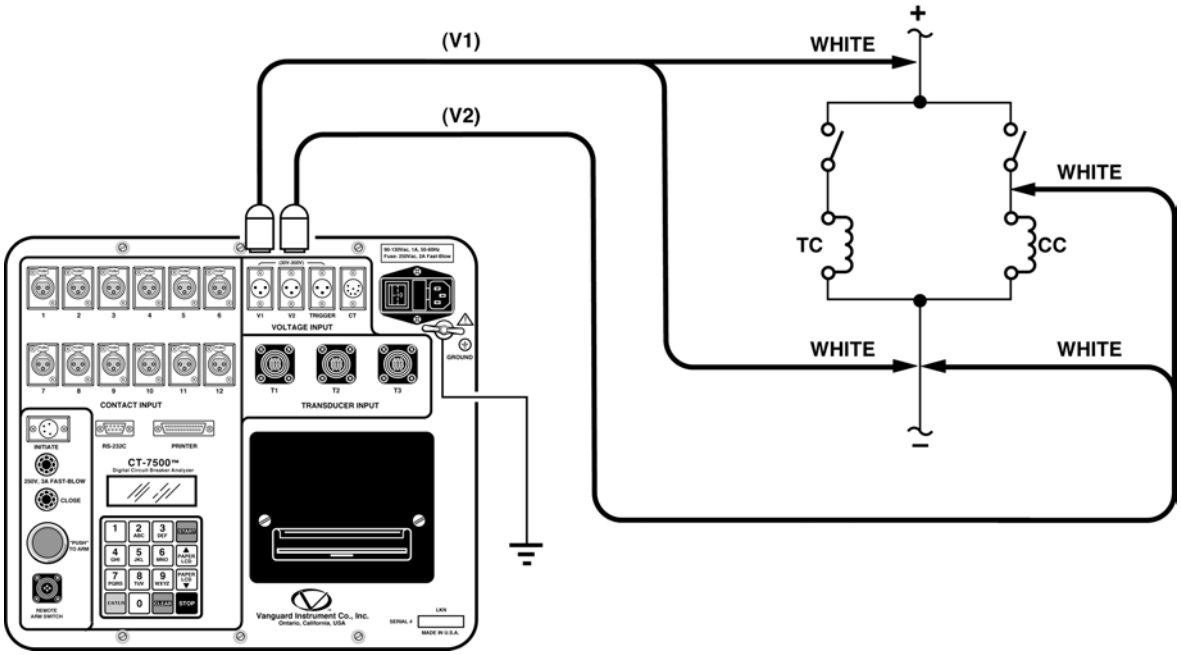


Figure 8-5. Typical Voltage-Monitoring Test Cable Hookup

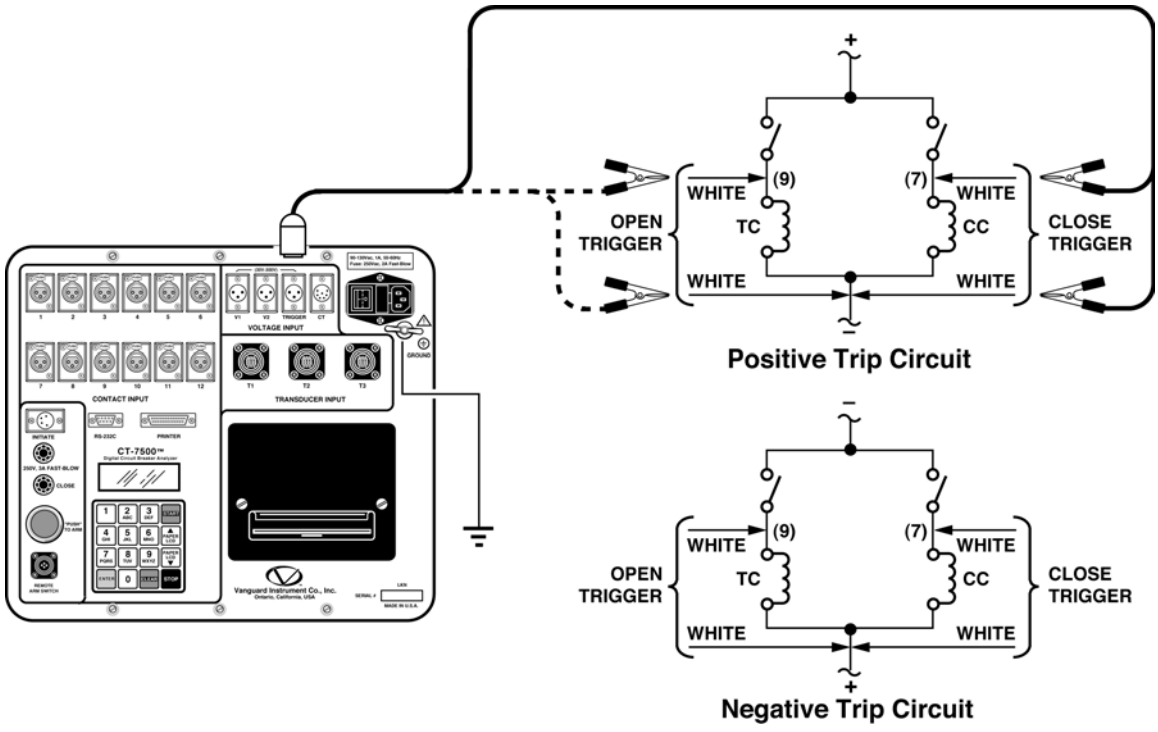


Figure 8-6. Typical External Trigger Hookup

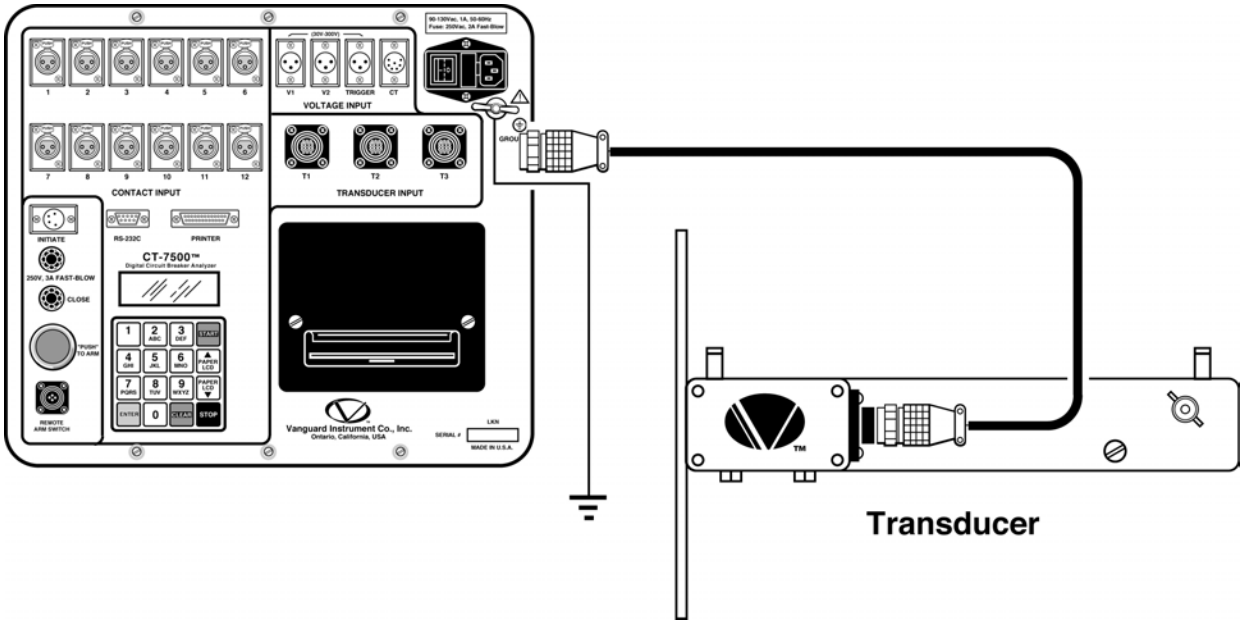


Figure 8-7. Transducer Cable Hookup

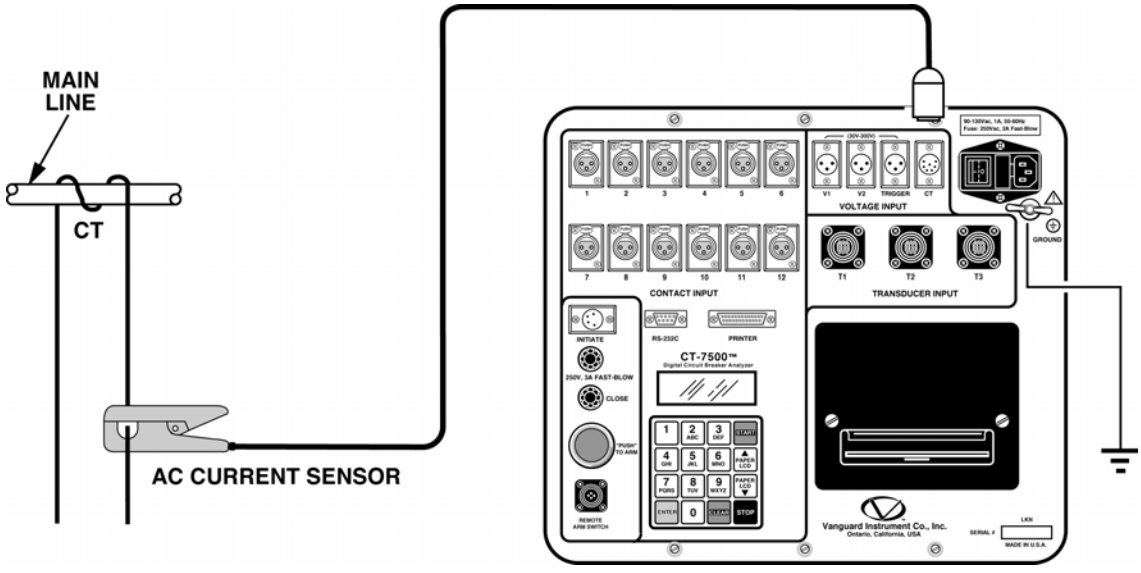


Figure 8-8. AC Current Sensor Hookup

9.0 OPERATING PROCEDURES

The main steps to time a circuit breaker are listed below (Figure 9-0). Figure 9-1 is a user's "map" of all menus for operating a CT-7500.

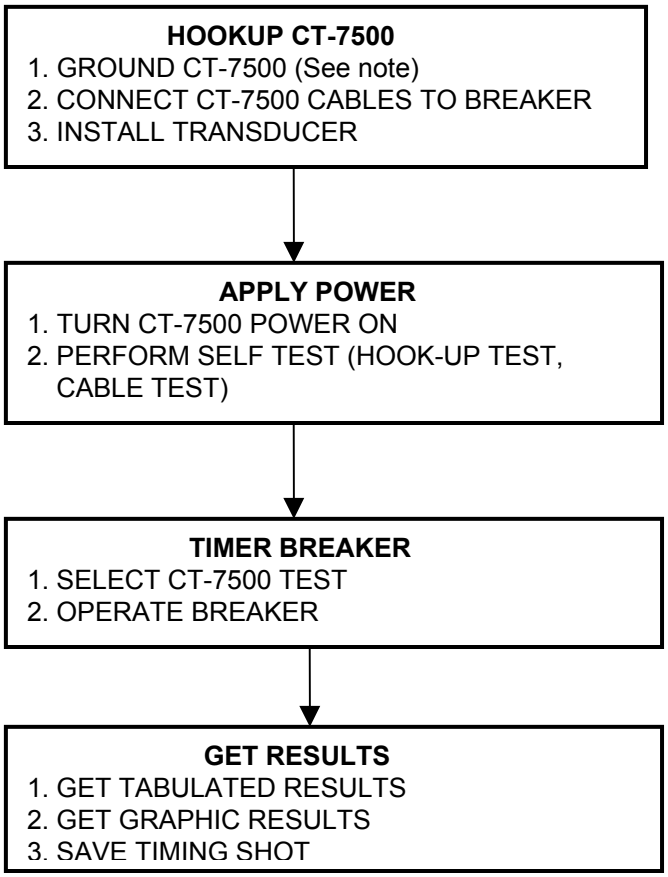


Figure 9-0. CT-7500 Operating Steps

Note

To reduce the possibility of damaging the CT-7500 contact channels by static discharge in the high voltage substation, we recommend the user to ground one side of the breaker's bushings.

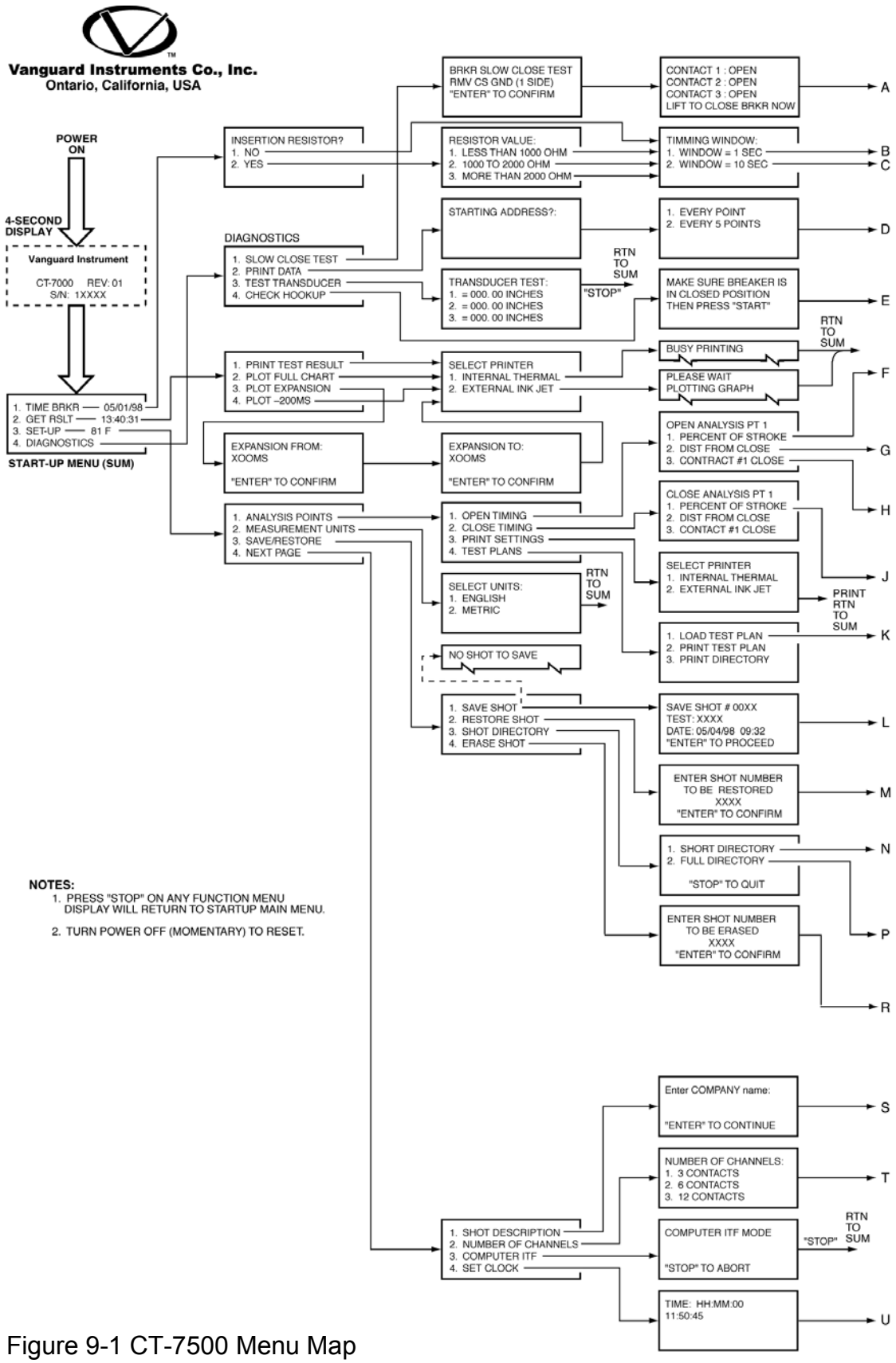


Figure 9-1 CT-7500 Menu Map

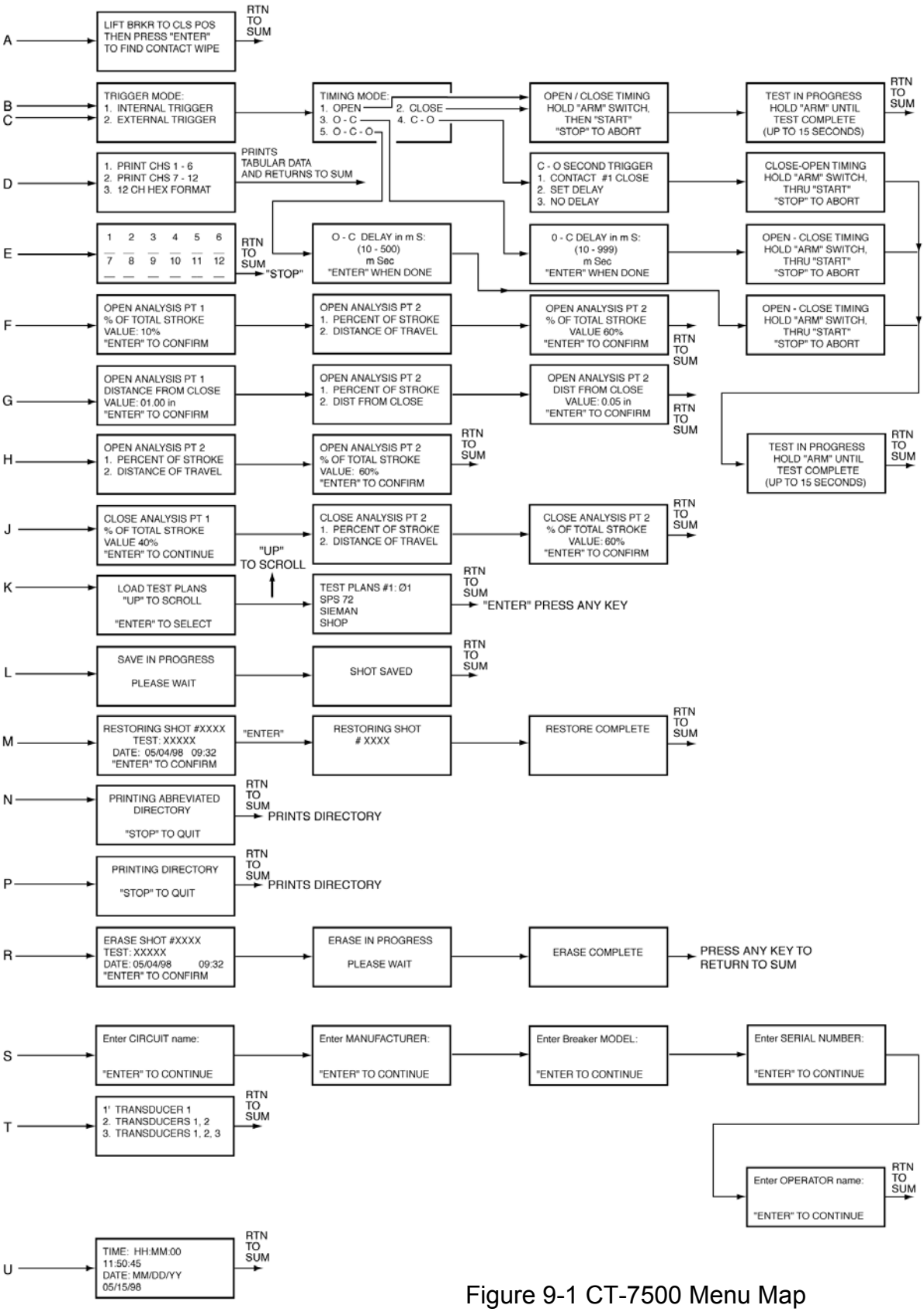


Figure 9-1 CT-7500 Menu Map

9.1 Timing A Circuit Breaker

Timing Breaker Under Quick-Shot Mode.

The CT-7500 will provide OPEN or CLOSE time only under the Quick-Shot mode. The user can have the CT-7500 to initiate the OPEN or CLOSE test, in this case the test report will show OPEN or CLOSE coil current reading and current wave form.

If the user operates the breaker for the Quick-Shot test (using External Trigger), no coil current reading or wave form will be recorded.

Timing Breaker Under Time-Travel Mode

The CT-7500 will initiate the breaker operation and do a timing test on the following operations:

- OPEN
- CLOSE
- OPEN-CLOSE
- CLOSE-OPEN
- OPEN-CLOSE-OPEN

Note

1. The CT-7500 can start OPEN-CLOSE operations, using a programmable delay (between OPEN and CLOSE commands) or no delay.

2.The CLOSE-OPEN can be started by the CT-7500, using several options:

- Contact #1 Close:

CT-7500 initiates a CLOSE command then OPEN command after detecting circuit breaker's contact closed. The CT-7500 detects breaker contact closed through contact channel #1.

- Set DELAY:

CT-7500 initiates a CLOSE command then OPEN command after a programmable delay (from a CLOSE command).

- No DELAY:

CT-7500 initiates a CLOSE command and OPEN command together. Since the circuit breaker is in the open state, the circuit breaker 52B contact allows the close coil to be energized to start the close command. When the circuit breaker is making the transition from open state to close state, the 52A contact will close allowing the breaker to initiate the open command.

3.The OPEN-CLOSE-OPEN operations can be initiated by the CT-7500, using a programmable delay between each of the operations (e.g., delays between OPEN to CLOSE and between CLOSE to OPEN).

9.1.1 Timing an OPEN Operation With No Insertion Resistor

Table 9-1. Open Operation With No Resistor

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT NO INSERTION RESISTOR.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SECOND 2.WINDOW = 10 SECONDS
3	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	1.INTERNAL TRIGGER 2.EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-0 5. O-C-O
5	SELECT OPEN OPERATION.	PRESS KEY #1.	OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
6	INITIATE OPEN COMMAND.	HOLD "ARM" KEY AND PRESS "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 15 seconds)
7	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.TIME BREAKER 2.GET RESULT 3.SET-UP 4.DIAGNOSTIC

Note

One-second timing windows are used for breaker timing; 10-second timing windows are used for circuit-switcher timing.

9.1.2 Timing an OPEN Operation With Insertion Resistors

The CT-7500 can time breakers with insertion resistors. The insertion resistor range is 10 to 7000 ohms. Any insertion resistor more than 7,000 ohms is detected as open circuit. Timing window results will show main contact timing and insertion resistor contact timing. Graphic reports show main contact and resistor contact activities on each of the channels.

Table 9-2. Open Operation With Insertion Resistor

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT INSERTION RESISTOR.	PRESS #2 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SECOND 2.WINDOW = 10 SECONDS
3	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	1.INTERNAL TRIGGER 2.EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-0 5. O-C-O
5	SELECT OPEN OPERATION.	PRESS KEY #1.	OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
6	INITIATE OPEN COMMAND.	HOLD "ARM" KEY AND PRESS "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 15 seconds)
7	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.TIME BREAKER 2.GET RESULT 3.SET-UP 4.DIAGNOSTIC

Note

The User can set the CT-7500 to print tabulated and graphic reports automatically after it completes a test. See section 9-21 for automatic print setting.

9.1.3 Timing CLOSE-OPEN Operation Using Contact Channel #1

The CLOSE-OPEN operation of the breaker simulates a condition where a breaker is closed on a fault. The CT-7500 first initiates a CLOSE command then sends an OPEN command only when it detects that main contact #1 is closed. This mode truly simulates the breaker closing into a fault condition in the field.

Table 9-3. Close-Open Operation with No Resistor

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT NO INSERTION RESISTOR.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SECOND 2.WINDOW = 10 SECONDS
3	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	1.INTERNAL TRIGGER 2.EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-0 5. O-C-O
5	SELECT CLOSE-OPEN OPERATION.	PRESS #4 KEY.	C-O SECOND TRIGGER 1. CONTACT #1 CLOSE 2. SET DELAY 3. NO DELAY
6	SELECT CONTACT #1 CLOSE.	PRES #1 KEY.	CLOSE-OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
7	INITIATE OPEN COMMAND.	HOLD "ARM" KEY AND PRESS "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 15 seconds)
8	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.TIME BREAKER 2.GET RESULT 3.SET-UP 4.DIAGNOSTIC.

Note

1. Users can program a delay from 10 to 500 ms between the CLOSE and OPEN commands. When a delay is used in this operation, it may not represent a true breaker condition.

2. Users can also program in no delay for this operation, in which case, the CLOSE and OPEN

commands are initiated at the same time. The breaker will start closing, the **OPEN circuit** is then enabled (by the A/B switch) allowing the OPEN operation.

9.2 Get Tabulated Timing Results Using Thermal Printer

Table 9-4. Get Tabulated Results

STEP	OPERATION	ACTION	DISPLAY
1	GET TIMING RESULTS.	PRESS #1 KEY.	1.PRINT TEST RESULTS 2.PLOT FULL CHART 3.PLOT EXPANSION 4.PLOT 0-200 MS
2	PRINT TABULATED RESULTS.	PRESS #1 KEY.	SELECT PRINTER 1. INTERNAL THERMAL 2. EXTERNAL INKJET
3	OUTPUT TABULATED RESULTS ON THERMAL PRINTER.	PRESS #1 KEY.	1. PRINT TEST RESULTS 2. PLOT FULL CHART 3. PLOT EXPANSION 4. PLOT 0-200 MS

Note

To get a tabulated report on the ink-jet printer, press key #2 in step #2. Ensure the ink-jet printer is connected to the CT-7500 for this report.

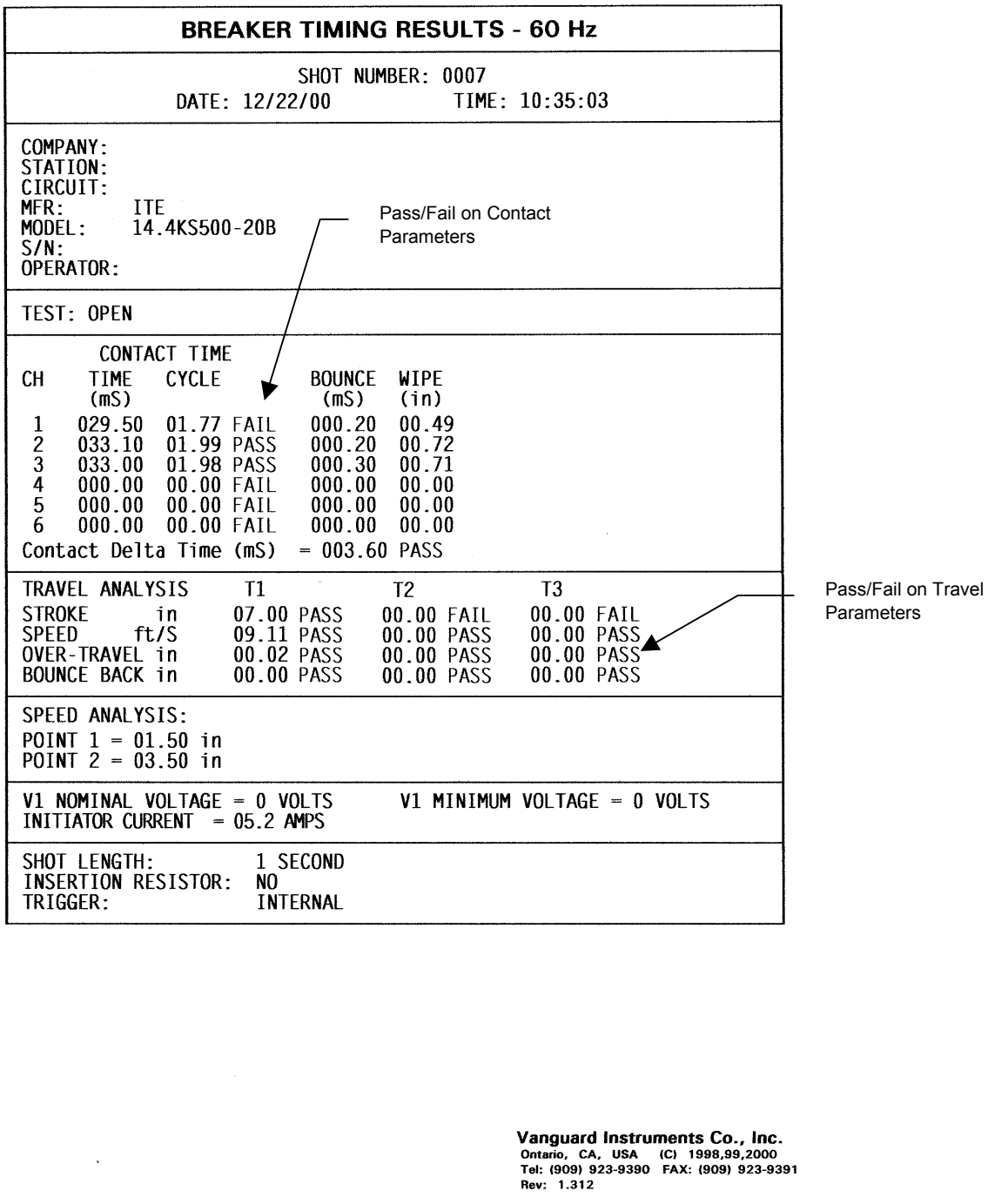
```
BREAKER TIMING RESULTS - 60 Hz

          SHOT NUMBER: 0005
DATE: 12/19/00    TIME: 07:03:52

COMPANY:   VANGUARD
STATION:   ONTARIO
CIRCUIT:
MFR:       ITE
MODEL:     14 4K
S/N:       12345
OPERATOR:  HAI

TEST: CLOSE

CONTACT TIME
CH   TIME   CYCLE        BOUNCE   WIPE
     <mS>                 <mS>    <in>
 1  181.50  10.89        001.70  00.77
 2  000.00  00.00        000.00  00.00
 3  181.40  10.88        001.70  00.78
DELTA TIME <mS>: 000.10

CT CHANNEL ANALYSIS
 TIME    CYCLE
 <mS>
184.70   11.08

TRAVEL ANALYSIS   T1
STROKE        in   07.08
SPEED      ft/S   05.72
OVER-TRAVEL in   00.29
BOUNCE BACK in   00.16

SPEED ANALYSIS:
POINT 1 = 01.00 in
POINT 2 = 05.00 in

V1 NOMINAL VOLTAGE = 52 VOLTS
V1 MINIMUM VOLTAGE = 37 VOLTS
INITIATOR CURRENT  = 05.1 AMPS

SHOT LENGTH:            1 SECOND
INSERTION RESISTOR:     NO
TRIGGER:                INTERNAL

VANGUARD INSTRUMENT CO., HPN (C) 1998.99.2000
1710 GREVILLEA CT. ONTARIO, CA 91761, USA
TEL (909)923-9390 FAX (909)923-9391
REV: 1.312
OPERATION: 0007
SERIAL NUMBER: 75032
CLOSE THRESHOLD = 020  OPEN THRESHOLD = 200  CT THRES = 127
SAMPLE = 011  VOLTAGE = 064
```

Figure 9-2. Typical Tabulated Printout of Open Operation on Thermal Printer

Note

1. Contact time is shown in both millisecond and cycles. From figure 9-2, contact channel #1 time is 181.50 ms or 10.89 cycles.
2. Contact bounce duration is 1.70 ms
3. Contact wipe is measured as .77 inch.
4. The slowest contact and fastest contact differential time is shown as contact delta:0.10 ms.
5. AC current sensor time is shown as CT Channel Analysis time in millisecond cycles. The CT time is shown as 184.70ms or 11.08 cycles.

   Since this print out was generated to show both Quick-Shot mode and Time-Travel mode; both CT time and contact-travel readings are shown on this report.
6. Breaker contact stroke is 7.08 inches.
7. Contact velocity calculation is 5.72 feet per second.
8. Contact over-travel distance is 0.29 inch.
9. Contact bounce-back distance is 0.16 inch.
10. Contact velocity calculation is from the 2 analysis points:
    Analysis point # 1 is 1.00 inch from fully closed position.
    Analysis point # 2 is 5.00 inches from fully closed position.
11. The DC power supply was monitored during test. The nominal voltage is 52V and the minimum is 37 V.
12. Initiate current is 5.1 amperes.
13. Timing shot duration is 1 second.
14. There is no insertion resistor in this test (no insertion resistor time is measured).
15. Trigger mode is internal (timing window starts at the same time the CT-7500 energized the circuit breaker).



BREAKER TIMING RESULTS - 60 Hz

SHOT NUMBER: 0007
DATE: 12/22/00 TIME: 10:35:03

COMPANY:
STATION:
CIRCUIT:
MFR: ITE
MODEL: 14.4KS500-20B
S/N:
OPERATOR:

Pass/Fail on Contact Parameters

TEST: OPEN

CH	CONTACT TIME TIME (mS)	CYCLE		BOUNCE (mS)	WIPE (in)
1	029.50	01.77	FAIL	000.20	00.49
2	033.10	01.99	PASS	000.20	00.72
3	033.00	01.98	PASS	000.30	00.71
4	000.00	00.00	FAIL	000.00	00.00
5	000.00	00.00	FAIL	000.00	00.00
6	000.00	00.00	FAIL	000.00	00.00

Contact Delta Time (mS) = 003.60 PASS

TRAVEL ANALYSIS	T1	T2	T3
STROKE in	07.00 PASS	00.00 FAIL	00.00 FAIL
SPEED ft/S	09.11 PASS	00.00 PASS	00.00 PASS
OVER-TRAVEL in	00.02 PASS	00.00 PASS	00.00 PASS
BOUNCE BACK in	00.00 PASS	00.00 PASS	00.00 PASS

Pass/Fail on Travel Parameters

SPEED ANALYSIS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

V1 NOMINAL VOLTAGE = 0 VOLTS V1 MINIMUM VOLTAGE = 0 VOLTS
INITIATOR CURRENT = 05.2 AMPS

SHOT LENGTH: 1 SECOND
INSERTION RESISTOR: NO
TRIGGER: INTERNAL

Vanguard Instruments Co., Inc.
Ontario, CA, USA (C) 1998,99,2000
Tel: (909) 923-9390 FAX: (909) 923-9391
Rev: 1.312

Figure 9-3. Typical tabulated Printout of an Open Operation on Ink-jet Printer.

9.3 Get Graphic Timing Results Using Thermal Printer

Table 9-5. Plot Chart and Tabulated Report

STEP	OPERATION	ACTION	DISPLAY
1	GET TIMING RESULTS.	PRESS #2 KEY.	1 PRINT TEST RESULTS 2 PLOT FULL CHART 3 PLOT EXPANSION 4 PLOT 0-200 MS
2	PLOT FULL CHART.	PRESS #2 KEY.	SELECT PRINTER 1. INTERNAL THERMAL 2. EXTERNAL INKJET
3	PRINT CHART ON THERMAL PAPER.	PRESS #1 KEY.	PLEASE WAIT PLOTTING GRAPH
4	RETURN TO MAIN MENU AFTER PRINT CHART.	NO ACTION.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

Note

1. Figure 9-4 shows a timing chart of a circuit breaker with contact activity on channel 1 and 3. A CT channel is also shown on this chart. Since this print out was generated to show both Quick-Shot mode and Time-Travel mode; both CT time and contact-travel readings are shown on this chart.

2. To get a graphic report on the ink-jet color printer, press key #2 in step # 2.

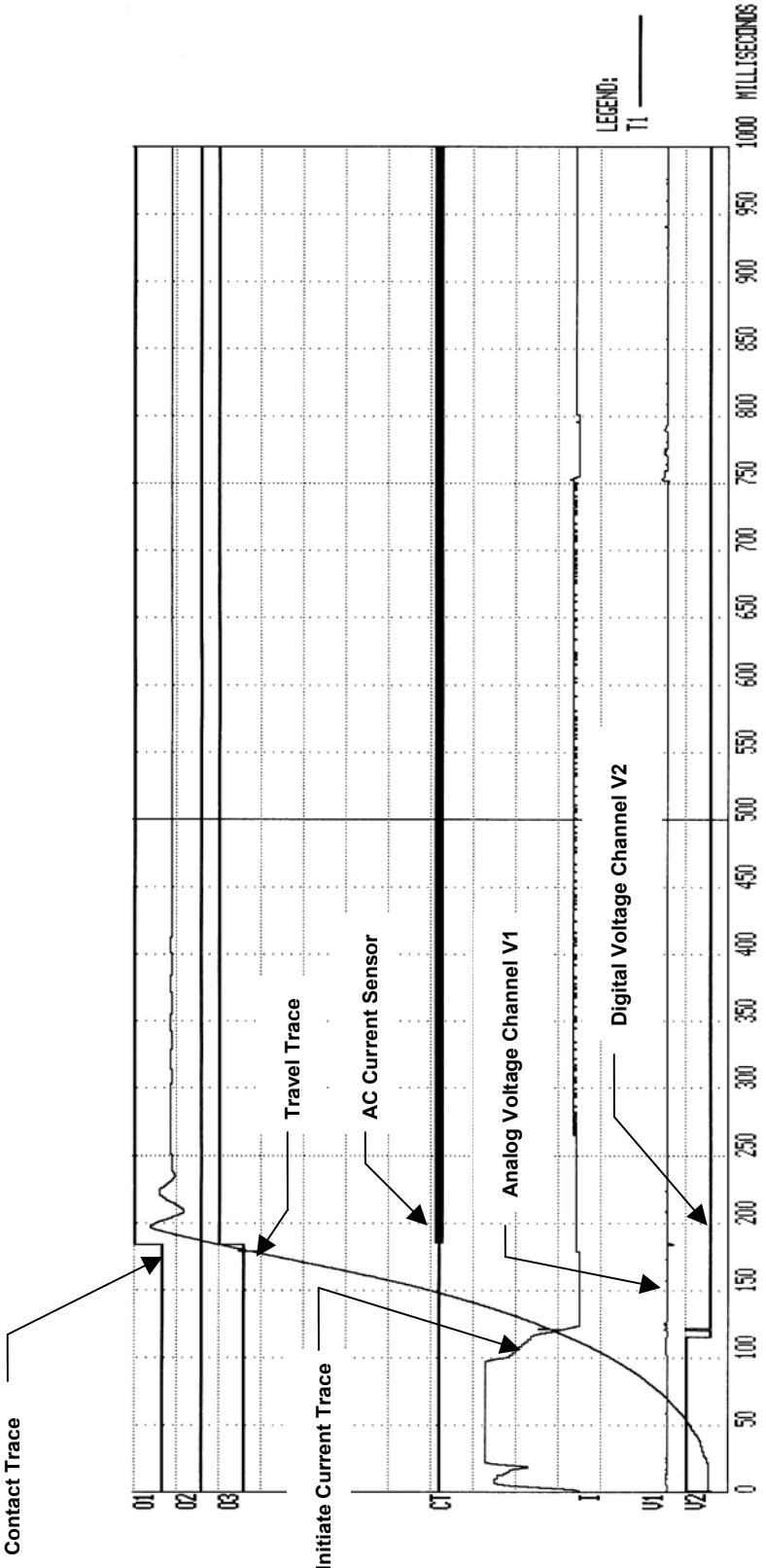


Figure 9-4. Typical Graphic Result on Thermal Printer

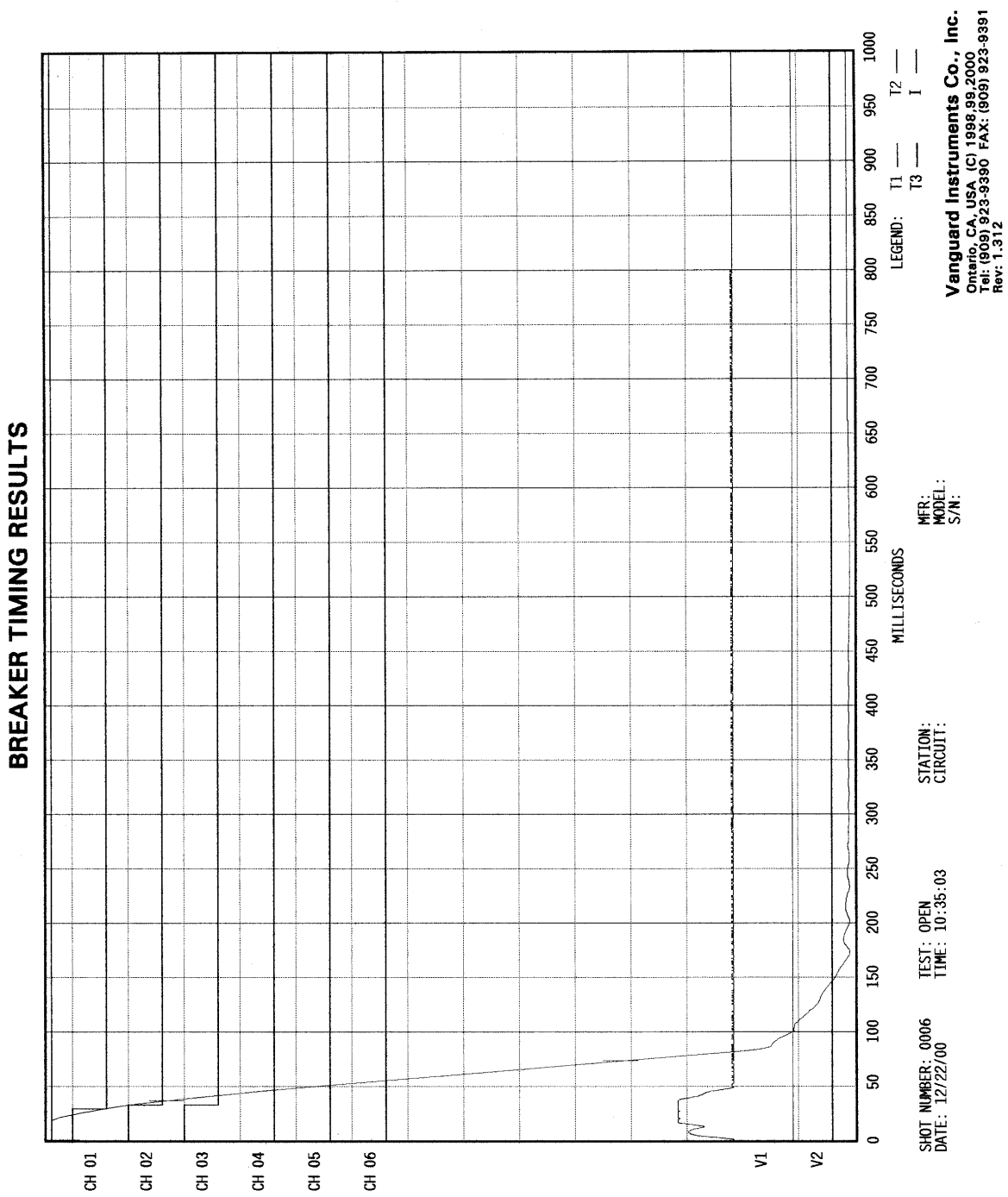


Figure 9-5. Typical Graphic Report on Ink-Jet Printer

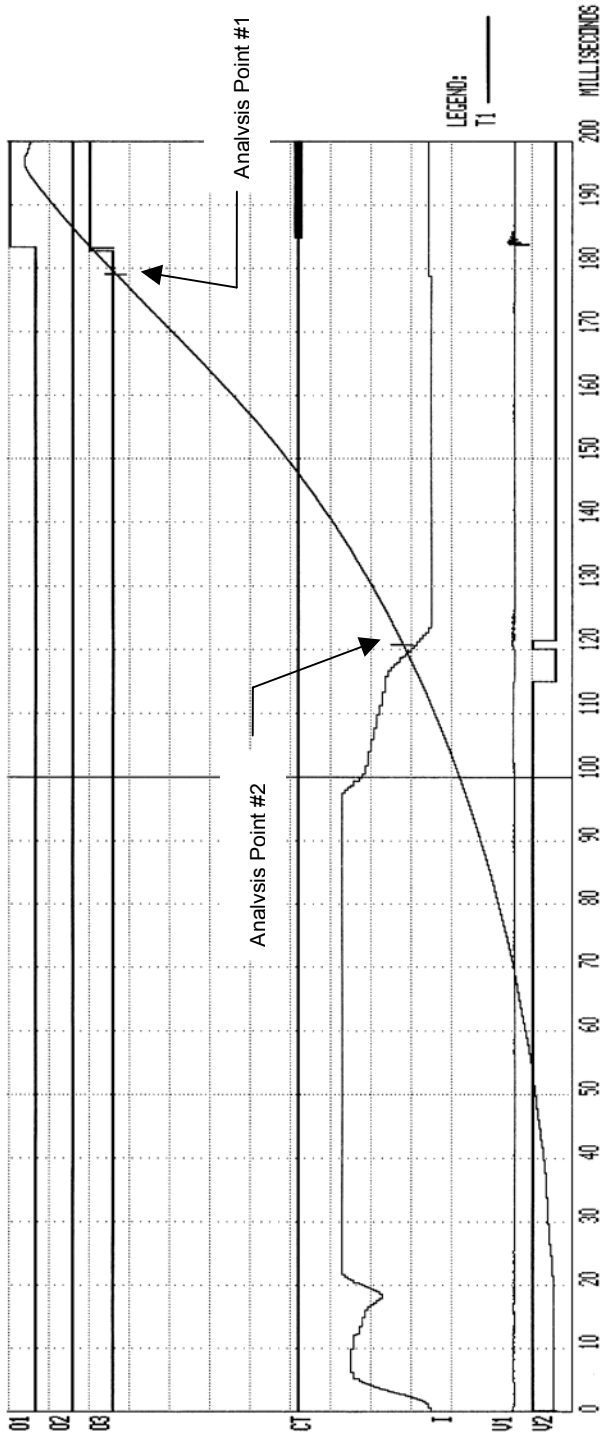


Figure 9-6. Expansion Graph from 0ms to 200ms on Thermal Printer

Note

Analysis point # 1 and point #2 is shown on chart.

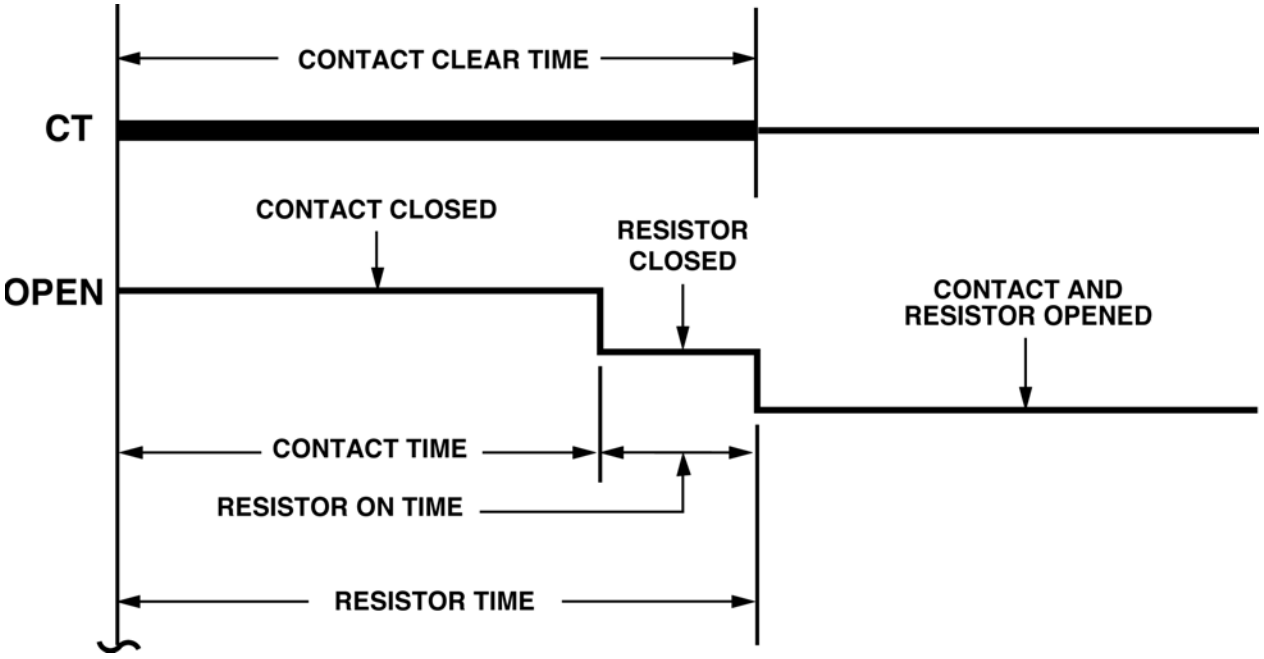


Figure 9-7. Open Timing Shot Graphics Interpretation

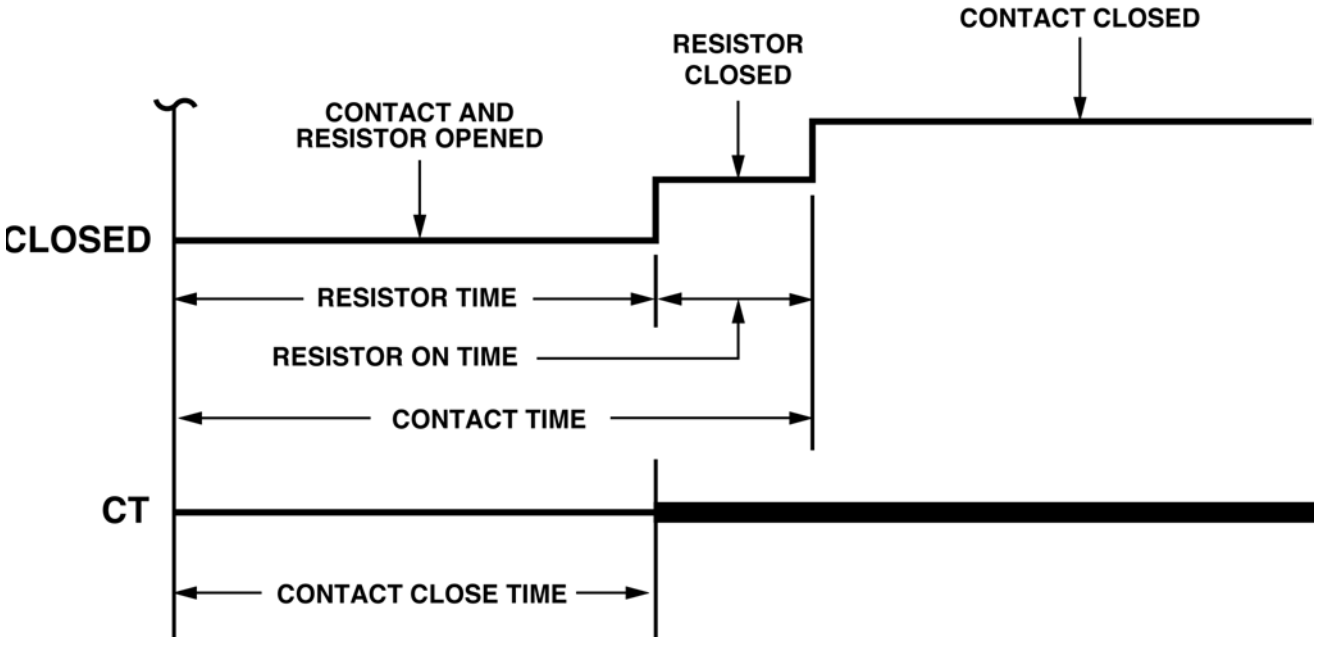


Figure 9-7A. Close Timing Shot Graphics Interpretation

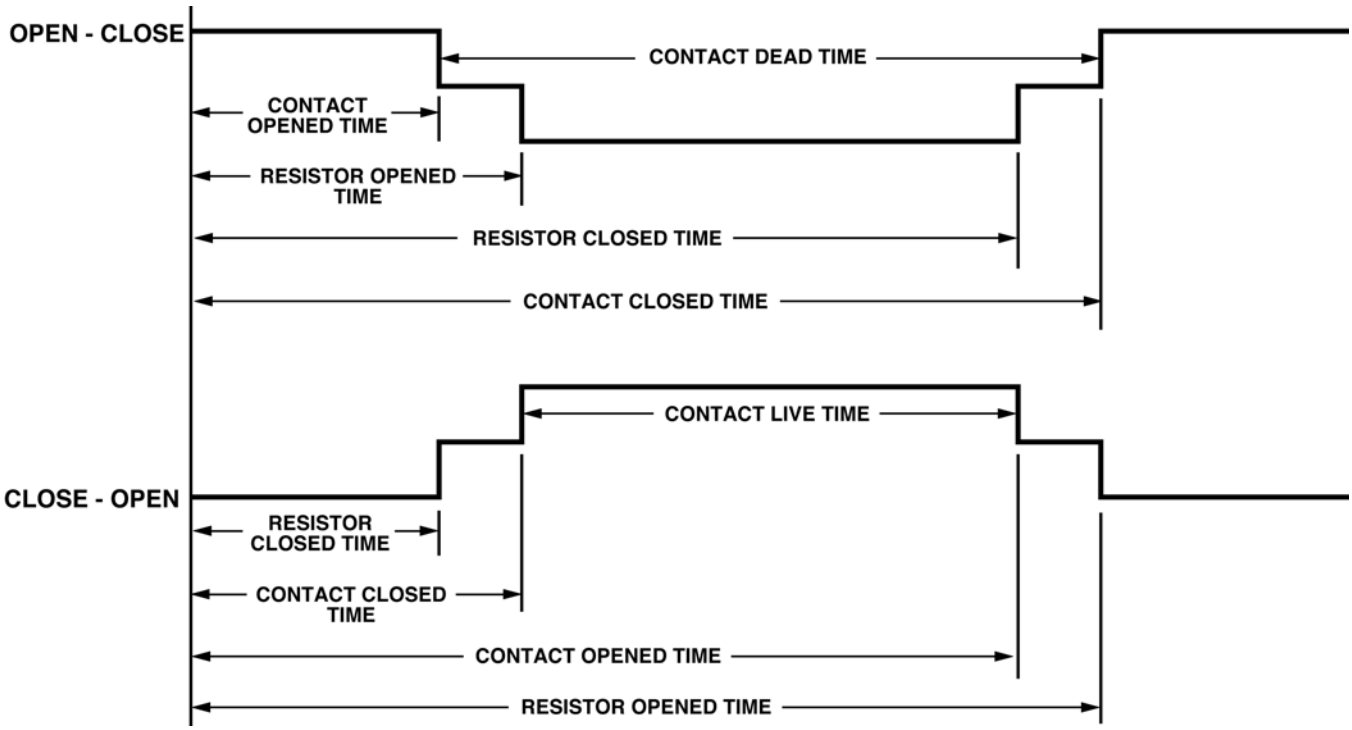


Figure 9-8. Open-Close and Close-Open Timing Shot Graphics Interpretation

9.4 Save Timing Shot in EEPROM

Table 9-6. Save Timing Shot In EEPROM

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SAVE/RECALL MENU.	PRESS #3 KEY.	1 ANALYSIS POINTS 2 MEASUREMENT UNITS 3 SAVE / RESTORE 4 NEXT PAGE
2	SELECT SAVE MENU.	PRESS #3 KEY.	1. SAVE SHOT 2. RECALL SHOT 3. SHOT DIRECTORY 4. ERASE SHOT
3	SELECT SAVE SHOT.	PRESS #1 KEY.	SAVE SHOT # XXXX TEST: CLOSE DATE: MM/DD/YY HH:MM "ENTER" TO CONFIRM
4	CONFIRM SAVING SHOT.	PRESS "ENTER" KEY.	SAVE IN PROCESS PLEASE WAIT
5	RETURN TO MAIN MENU.	PRESS ANY KEY.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

Notes

Timing shot storage capability varies, depending upon the size of the shots. The CT-7500 will assign an ID for each of the shots stored in EEPROM.

9.5 Print EEPROM Timing Shot Directory

Table 9-7. Print Timing Shot Directory

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SAVE / RESTORE MENU.	PRESS #3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT SHOT DIRECTORY MENU.	PRESS #3 KEY.	1. SAVE SHOT 2. RESTORE SHOT 3. SHOT DIRECTORY 4. ERASE SHOT
3	SELECT SHORT DIRECTORY.	PRESS # 1 KEY.	1. SHORT DIRECTORY 2. FULL DIRECTORY "STOP" TO QUIT
4	PRINT SHOT DIRECTORY NOW.	NO ACTION.	PRINTING ABBREVIATED DIRECTORY "STOP" TO QUIT
5	RETURN TO MAIN DIRECTORY.	NO ACTION.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

Note

1. The CT-7500 will print out shot IDs of 10 last timing shots stored in EEPROM when "Short Directory" is selected.

2. The CT-7500 will print out shot IDs of all timing shots stored in EEPROM if "Full Directory" is selected.

A typical shot directory print out is shown on next page.

TIMING SHOT ABBREVIATED DIRECTORY

SHOT NUMBER: 0004

DATE	: 12/18/00	TIME	: 08:08:42
COMPANY	:	MFGR	:
STATION	:	MODEL	:
CIRCUIT	:	SERIAL	:
OPERATOR:		TEST	: OPEN

SHOT NUMBER: 0003

DATE	: 12/18/00	TIME	: 08:07:03
COMPANY	:	MFGR	:
STATION	:	MODEL	:
CIRCUIT	:	SERIAL	:
OPERATOR:		TEST	: CLOSE

SHOT NUMBER: 0002

DATE	: 12/18/00	TIME	: 07:57:42
COMPANY	:	MFGR	:
STATION	:	MODEL	:
CIRCUIT	:	SERIAL	:
OPERATOR:		TEST	: OPEN

SHOT NUMBER: 0005

DATE	: 12/18/00	TIME	: 07:56:10
COMPANY	: VANGUARD INSTRUMENT	MFGR	: ITE
STATION	:	MODEL	: 12345
CIRCUIT	: 14 4	SERIAL	:
OPERATOR:	HAI	TEST	: CLOSE

Figure 9-9. Timing Shot Directory Printout On Thermal Printer

9.6 Recall a Timing Shot

The following steps are used to recall a timing shot stored in EEPROM to working memory. Once a timing shot is recalled, the user can ask for test results from the thermal printer or the color ink-jet printer.

Table 9-8. Recall a Timing Shot

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SETUP MENU.	PRESS #3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT SAVE/RESTORE SHOT.	PRESS # 3 KEY.	1. SAVE SHOT 2. RESTORE SHOT 3. SHOT DIRECTORY 4. ERASE SHOT
3	SELECT RESTORE SHOT.	PRESS #2 KEY.	ENTER SHOT NUMBER TO BE RESTORED xxxx "ENTER" TO CONFIRM
4	ENTER SHOT NUMBER TO BE RESTORED.	PRESS KEY 0 TO 9 FOR SHOT ID THE "ENTER" KEY.	ENTER SHOT NUMBER TO BE RESTORED XXXX "ENTER" TO CONFIRM
5	CONFIRM SHOT TO BE RESTORED.	PRESS "ENTER" KEY.	RESTORING SHOT # XXXX TEST: YYYY DATE: MM\DD\YY HH:MM "ENTER" TO CONFIRM
6	RETURN TO MAIN MENU.	PRESS ANY KEY.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTICS

9.7 Deleting a Timing Shot

Users can delete a specific timing shot from the CT-7500 EEPROM memory by using the steps described in the table below.

Table 9-9. Delete a Timing Shot

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINTS 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT SAVE / RESTORE MENU.	PRESS # 3 KEY.	1. SAVE SHOT 2. RESTORE SHOT 3. SHOT DIRECTORY 4. ERASE SHOT
3	SELECT ERASE SHOT.	PRESS # 4 KEY.	ENTER SHOT NUMBER TO BE ERASED XXXX "ENTER" TO CONFIRM
4	ENTER SHOT NUMBER.	PRESS KEY 0-9 TO SELECT SHOT NUMBER, PRESS "ENTER" TO CONFIRM.	ERASE SHOT # XXXX TEST: YYYY DATE: MM\DD\YY HH:MM "ENTER" TO CONFIRM
5	CONFIRM ERASE SHOT.	PRESS "ENTER".	ERASE IN PROCESS PLEASE WAIT
6	WAIT FOR SHOT BEING ERASED.	NO ACTION.	ERASE COMPLETE
7	RETURN TO MAIN MENU.	PRESS ANY KEY.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

9.8 Recall a Breaker Test Plan

A breaker test plan contains breaker maximum/minimum operating parameters. A typical list of operating parameters is shown as follows:

- Max/Min Contact/Resistor Trip Time.
- Max/Min Contact/Resistor Close Time.
- Max Contact Spread Time.
- Max Resistor Contact Spread Time.
- Max/Min Stroke.
- Max/Min Trip Velocity.
- Max/Min Close Velocity.
- Max/Min Over Travel.
- Max/Min Bounce Back.
- Trip Analysis Points.
- Close Analysis Points.

By recalling a Test Plan before testing, a user doesn't have to set analysis points to calculate the Trip or Close velocity of the circuit-breaker contacts. Since a Test Plan contains other breaker test parameters, the test report also displays a Pass/Fail status for each parameter tested.

Table 9-10. Recalling a Test Plan

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS #3 KEY.	1. ANALYSIS POINTS 2. MEASUREMENT UNIT 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT ANALYSIS MENU.	PRES # 1 KEY.	1. OPEN TIMING 2. CLOSE TIMING 3. PRINT SETTING 4. TEST PLANS
3	SELECT TEST PLANS.	PRESS # 4 KEY.	1. LOAD TEST PLAN 2. PRINT TEST PLAN 3. PRINT DIRECTORY
4	SELECT LOAD TEST PLAN.	PRESS # 1 KEY.	LOAD TEST PLAN "UP" TO SCROLL "ENTER" TO SELECT
5	VIEW TEST PLAN HEADER.	PRESS UP ARROW KEY TO SCROLL.	DISPLAY TEST PLAN HEADER
6	CONFIRM TEST PLAN TO BE LOADED.	PRESS "ENTER" KEY.	1. TEST BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

9.9 Print a Breaker Test Plan

The user can print a breaker test plan stored in the CT-7500 EEPROM

Table 9-11. Print a Breaker Test Plan

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT ANALYSIS POINTS.	PRESS # 1 KEY.	1. OPEN TIMING 2. CLOSE TIMING 3. PRINT SETTINGS 4. TEST PLAN
3	SELECT TEST PLAN.	PRESS # 4 KEY.	1. LOAD TEST PLAN 2. PRINT TEST PLAN 3. PRINT DIRECTORY
4	SELECT PRINT TEST PLAN.	PRESS # 2 KEY.	ENTER PLAN NUMBER "ENTER" TO CONTINUE
5	ENTER PLAN NUMBER.	PRESS # 0-9 KEY.	ENTER PLAN NUMBER: 02 "ENTER" TO CONTINUE
6	CONFIRM TEST PLAN.	PRESS “ENTER" KEY.	SELECT PRINTER 1. INTERNAL THERMAL 2. EXTERNAL INK JET
7	PRINT ON THERMAL PRINTER.	PRESS # 1 KEY.	1. TIMER BRKR 2. GET RESLT 3. SET UP 4. DIAGNOSTIC

TEST PLAN NUMBER 1

MFR: 14.4KS500-20B
TYPE: ITE
COMMENT:

CONTACT TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	035.0	180.0
MIN <mS>	030.0	170.0
DELTA LIM <mS>	006.0	008.0

RESISTOR TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	999.0	999.0
MIN <mS>	000.0	000.0
DELTA LIM <mS>	010.0	010.0

TRAVEL PARAMETERS

	STRK in	VEL ft/S	O-TVL in	BNC-BK in
OPEN HI	07.25	43.64	00.20	00.20
OPEN LOW	06.75	00.00	00.00	00.00
CLOSE HI	07.25	07.00	00.40	00.25
CLOSE LO	06.75	04.50	00.00	00.00

OPEN SPEED ANALYSIS POINTS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

CLOSE SPEED ANALYSIS POINTS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

Figure 9-10. Typical Test-Plan Printout on Thermal Printer

9.10 Print Breaker Test Plan Directory

The user can print a breaker test plan directory stored in the CT-7500 EEPROM using the steps in table below:

Table 9-12. Print a Breaker Test Plan Directory

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT ANALYSIS POINTS.	PRESS # 1 KEY.	1. OPEN TIMING 2. CLOSE TIMING 3. PRINT SETTINGS 4. TEST PLAN
3	SELECT TEST PLAN.	PRESS # 4 KEY.	1. LOAD TEST PLAN 2. PRINT TEST PLAN 3. PRINT DIRECTORY
4	SELECT PRINT TEST PLAN DIRECTORY.	PRESS # 3 KEY.	1. TIMER BRKR 2. GET RESLT 3. SET UP 4. DIAGNOSTIC

TEST PLAN DIRECTORY

```
TEST PLAN #:   1
BRKR TYPE:    14.4KS500-20B
BRKR MFR:     ITE
COMMENTS:

TEST PLAN #:   2
BRKR TYPE:    SP-72.5-23-2
BRKR MFR:     SIEMENS
COMMENTS:
```

Figure 9-11. Typical Test Plan Directory Printout.

9.11 Shot Description

The CT-7500 lets users enter breaker and test data identification (ID). This data includes the names of the company, station, circuit, and manufacturer, as well as the breaker's model and serial number, and the operator's name. These ID data will print out on the header section of the shot tabulated report.

If the user saves the timing shot, this data will also be saved with the timing shot and the time and date.

The user selects the alpha-numeric entry by pressing the appropriate key: To select a letter "A," the user must press key #2 twice. To select letter "C," the user must press key #2 four times etc.

To move the cursor forward, use the UP ARROW key. To move cursor backwards, use the DOWN ARROW key. Use the CLEAR key to enter a space.

Table 9-13. Entering Shot Identification Header

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS #3 KEY.	1. ANALYSIS POINTS 2. MEASUREMENT UNIT 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. COMPUTER IF 4. SET CLOCK
3	SELECT SHOT DESCRIPTION.	PRESS # 1 KEY.	ENTER COMPANY NAME XXXXXX "ENTER" TO CONFIRM
4	ENTER COMPANY NAME.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER STATION NAME XXXXXX "ENTER" TO CONFIRM
5	ENTER STATION NAME.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER CIRCUIT NAME XXXXXX "ENTER" TO CONFIRM
6	ENTER CIRCUIT NAME.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER MANUFACTURER NAME XXXXXX "ENTER" TO CONFIRM
7	ENTER MANUFACTURER NAME.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER BREAKER MODEL XXXXXX "ENTER" TO CONFIRM

Table 9-13. Entering Shot Identification Header (Con't)

STEP	OPERATION	ACTION	DISPLAY
8	ENTER SERIAL NUMBER.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER SERIAL NUMBER XXXX "ENTER" TO CONFIRM
9	ENTER OPERATOR NAME.	PRESS # 0-9 KEYS PRESS "ENTER" TO CONFIRM.	ENTER OPERATOR NAME XXXX "ENTER" TO CONFIRM
10	RETURN TO MAIN MENU.	NO ACTION.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

9.12 CT-7500 Channel Configuration

The CT-7500 is available with 3-, 6-, or 12- contact inputs. Under most common timing conditions, the user needs to use only 3 contact timing channels and 1 travel transducer. There is no need to print more than 3 timing channels and 1 transducer channel on the graphic and tabulated report. The CT-7500 will always default to 3 contact channels (channel 1, 2, and 3) and 1 transducer channel (transducer channel #1) after power is applied to the unit. The user can always turn on the rest of the timing channels and transducer channels by following steps shown in table below:

Table 9-14. Select Channel Configuration

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS #3 KEY.	1. ANALYSIS POINTS 2. MEASUREMENT UNIT 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS #4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. COMPUTER IF 4. SET CLOCK
3	SELECT NUMBER OF CHANNEL.	PRESS #2 KEY.	NUMBER OF CHANNELS 1. 3 CONTACTS 2. 6 CONTACTS 3. 12 CONTACTS
4	SELECT 3 CHANNELS ,OR 6 CHANNELS, OR 12 CHANNELS.	PRESS # 1, OR 2, OR 3 KEY.	1. TRANSDUCER 1 2. TRANSDUCER 1,2 3. TRANSDUCER 1,2,3
5	SELECT 1 TRANSDUCER, OR 2, OR 3.	PRESS # 1, OR 2, OR 3 KEY.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

9.13 Computer Interface

Each CT-7500 has an RS-232C port. A Breaker Analysis Software package (provided with the CT-7500) allows an IBM PC to communicate with a CT-7500. This software (operating under Windows 95, Windows 98, Windows Me, Windows 2000, and Windows NT environment) allows users to upload timing shots stored in EEPROM to the IBM PC. From the user's IBM PC, the user can now re-analyze breaker timing shots and output timing report through an office printer. Since timing shots are stored in an office PC, users can create a data base of a breaker's timing history.

A breaker's test plan can also be downloaded and stored in the CT-7500 EEPROM. Up to 20 test plans can be stored in a CT-7500. Consult the CT-7500 software manual for further details.

Follow the steps in the Table 9-15 below to put the CT-7500 under computer control:

Table 9-15. Selecting or Aborting Computer Control

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. COMPUTER IF 4. CLOCK 5.PRINT
3	SELECT COMPUTER INTERFACE.	PRESS # 3 KEY.	COMPUTER IF MODE "STOP" TO ABORT

Notes

1. An interconnect cable must be run between Timer's RS-232C port and a compatible IBM PC.

2. Refer to the Breaker timing software manual for the software to run on the IBM-compatible computer.

3. The CT-7500's RS-232 connector pinout is in the chart at the right:

4. The operator is required to put the CT-7500 under computer control before executing the PC program.

PIN No.	SIGNAL NAME
2	Tx
3	Rx
5	GND

9.14. Breaker Travel Analysis

The CT-7500 travel analysis includes breaker stroke, over-travel, bounce-back, and contact-wipe distances, and contact velocity calculation.

9.14.1 Breaker Stroke

The CT-7500 uses a digital transducer to measure a breaker's contact stroke, over-travel, and bounce-back. The digital transducer output is 200 counts per linear inch of travel; the resolution is accurate to 1/200 inch. The output resolution is ±0.01 inch on the test result report.

Unlike slide-wire transducers, the CT-7500 transducer needs no calibration or setup. A user verifies transducer function by selecting a diagnostic test for the transducer (paragraph 9.19).

9.14.2 Breaker Over-travel Distance

Over-travel is a distance the contact moves beyond the resting position. Over-travel is typically found in the Close Operation.

9.14.3 Breaker Bounce-Back Distance.

Bounce-back is the distance the breaker contact moves before the resting position after over-travel. Again, bounce-back is typically found in the Close Operation.

9.14.4 Contact Wipe.

Contact wipe is the distance measured from the close position to the contacts touching (or parting). In the Close Operation, contact wipe is measured from the contacts touching position to the final close position.

In the Open Operation, contact wipe is measured from the close position to contact break (or parting) position.

NOTE

Contact wipe is measured during operation. This measurement may not be as accurate as measurement done using the slow close mode. It is recommended the user use the Slow Close Test (paragraph 9.18) to verify wipe measurement if required.

9.14.5 Breaker Velocity

The CT-7500, when used with a travel transducer, calculates the breaker contact velocity through the arc zone. Users must program the calculation points (analysis points) on the travel curve for the unit to calculate contact velocity. Analysis points selection and setup are discussed in the following paragraphs.

9.14.6 Analysis Point Selections.

Analysis points are used to calculate average contact speed through the contact's arc zone. The analysis points are usually specified by the breaker manufacturers. The analysis points are fully programmable in the Timer by the user. The Timer will store two setups for calculating velocity (one each for open and close). These setups remain in the Timer's RAM memory until changed by the operator.

9.14.7 Analysis Point No.1.

Three selections are available to the user for setting analysis point No. 1:

1. PERCENTAGE OF STRK
2. DISTANCE FROM CLOSE
3. CONTACT #1

a. Percentage of Stroke:

Percentage of stroke is distance based upon percentage of total breaker stroke distance. ***This distance is always measured from the starting point at the fully closed position of the breaker contacts.***

b. Distance From Close:

Distance from Close range is selectable from 00.0 inch to 99.99 inches or from 0.0 centimeter to 99.90 centimeters. ***Again, this distance is referenced from the contact's closed position.***

c. Contact Point #1:

Contact point is the distance from the contact's closed position to the point where it is in transition from close-to-open (or open-to-close position). ***Contact channel #1 will be used for this selection.***

9.14.8 Analysis Point No. 2.

Only two selections for analysis point 2 are available to the user:

1. PERCENTAGE OF STRK
2. DISTANCE FROM CLOSE

The selection of analysis point No. 2 is the same as for analysis point No. 1.

NOTE

1. Average velocity through the arc zone is calculated by using the following formula:

$$V_{ave} = \text{Distance} \div \text{Time}$$

2. The current breaker contact velocity will be recalculated based on data stored in memory (RAM) after any new analysis point(s) is selected. The user does NOT need to operate the breaker again to acquire new contact velocity data after changing the analysis points (a new velocity is calculated from travel data stored in memory from the last operation).

3. For complex velocity calculations, the user can download a test plan to the CT-7500 from an IBM PC. This test plan can be recalled and used to calculate a breaker's contact velocity.

9.15 Set-Up Open Analysis Points

Table 9-16. Setting Up "OPEN" Analysis Points Using Distance

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT ANALYSIS POINT.	PRESS # 1 KEY.	1. OPEN TIMING 2. CLOSE TIMING 3. PRINT SETTING 4. TEST PLAN
3	SELECT OPEN ANALYSIS.	PRESS # 1 KEY.	OPEN ANALYSIS PT 1 1. PERCENT OF STROKE 2. DISTANCE FROM CLOSE 3. CONTACT #1
4	SELECT DISTANCE FROM CLOSE.	PRESS # 2 KEY.	OPEN ANALYSIS PT 1 DISTANCE FROM CLOSE VALUE: XX.XX in "ENTER" TO CONFIRM
5	ENTER 1 INCH.	PRESS # 0-9 KEY.	OPEN ANALYSIS PT 1 DISTANCE FROM CLOSE VALUE: 01.00 in "ENTER" TO CONFIRM
6	CONFIRM ENTRY.	PRESS "ENTER" KEY.	OPEN ANALYSIS PT 2 1. PERCENTAGE OF STROKE 2. DISTANCE FROM CLOSE
7	SELECT DISTANCE FROM CLOSE.	PRESS # 2 KEY.	OPEN ANALYSIS PT 2 DISTANCE FROM CLOSE VALUE: XX.XX in "ENTER" TO CONFIRM

Table 9-16. Setting Up "OPEN" Analysis Points Using Distance (Con't)

STEP	OPERATION	ACTION	DISPLAY
8	ENTER 5 INCHES.	PRESS # 0-9 KEYS.	OPEN ANALYSIS PT 2 DISTANCE FROM CLOSE VALUE: 02.00 in "ENTER" TO CONFIRM
9	CONFIRM ENTRY.	PRESS "ENTER" KEY.	1.TIME BRKR 2.GET RSLT 3.SET UP 4.DIAGNOSTICS

NOTES

1. If an entry is not correct, re-enter digits until display shows desired numbers, then press "ENTER" key.

2. Analysis Point #1 is 1.00 inch from the fully closed position.

3. Analysis Point #2 is 2.00 inches from the fully closed position.

9-16. English/Metric Selection

The CT-7500 supports and displays both English and Metric calculations from the breaker's travel parameters (stroke, velocity, (etc.). The user can switch from one to the other by following the steps in Table 9-17, below:

Table 9-17. Select Metric Units of Measure

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT MEASUREMENT UNITS.	PRESS # 2 KEY.	SELECT UNITS 1. ENGLISH 2. METRIC
3	SELECT METRIC.	PRESS # 2 KEY.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

9.17 Set CT-7500 Internal Clock

The CT-7500 has an internal clock with a lithium battery. The clock's time and date is displayed on the LCD screen. When a timing shot is stored in EEPROM, time and date are also stored. To set the clock, perform the steps in the following table:

Table 9-18. Setting the Clock and Calendar

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. COMPUTER IF 4. CLOCK 5.PRINT
3	SELECT SET CLOCK.	PRESS # 4 KEY.	TIME: HH:MM:00 XX:YY:00
4	ENTER HOURS AND MINUTES.	PRESS # 0-9 KEY.	TIME: HH:MM:00 XX:YY:00 XX:YY:00 DATE: MM/DD/YY XX/YY/ZZ
5	ENTER MONTH, DATE, YEAR.	PRESS # 0-9 KEY.	TIME: HH:MM:00 XX:YY:00 XX:YY:00 DATE: MM/DD/YY XX/YY/ZZ XX/YY/ZZ
6	RETURN TO MAIN MENU.	NO ACTION.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

Note

The real time clock battery is good for 3 years. Loosing the clock battery will not affect the CT-7500 performance.

9.18 Slow-Close Test

The CT-7500 offers a unique feature called a "slow-close" test. This test lets users measure the distance of a breaker's contact travel from fully opened position to contact "touch" position and contact wipe (or penetration) distance. This test requires the operator manually jack the breaker's contact from the fully open position to the fully closed position.

Contact channel 1, 2, 3, and transducer channel 1 will be used for this test. The CT-7500 will measure the contact touch and contact wipe (penetration) of each contact channel.

Contact touch is the distance measured from contact fully open to the first position contact channel electrically closed.

Contact wipe (or penetration) distance is measured from the contact position first electrically closed to the final closed (latching) position.

Table 9-19. Performing a Slow-Close Test

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC MENU.	PRESS # 4 KEY.	1. SLOW CLOSE TEST 2. PRINT DATA 3. TEST TRANSDUCER 4. CHECK HOOK UP
2	SELECT SLOW CLOSE TEST.	PRESS # 1 KEY.	BREAKER SLOW CLOSE TEST RMV CB GND (1 SIDE) "ENTER" TO BEGIN
3	START SLOW CLOSE TEST.	PRESS "ENTER" KEY.	CONTACT 1:OPEN CONTACT 2:OPEN CONTACT 3:OPEN LIFT TO CLS BREAKER NOW
4	CONTINUE TO CLOSE BREAKER.	NO ACTION.	LIFT BRKR TO CLS POS THEN PRESS "ENTER" TO FIND CONTACT WIPE
5	RETURN TO MENU.	NO ACTION.	1. TIME BRKR 2. GET RSLT 3. SET UP 4. DIAGNOSTIC

Notes

The user can also save a slow-close test report in EEPROM. A typical report of a slow-close test is shown on next page.

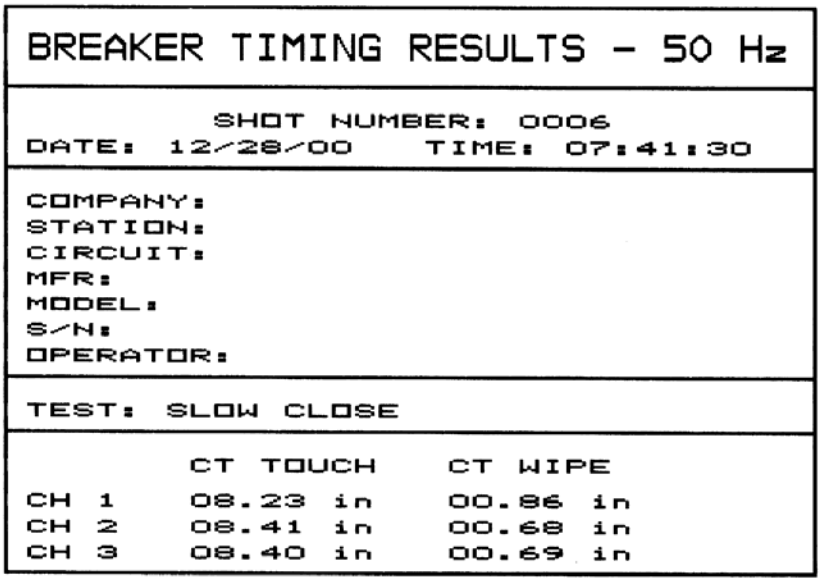


Figure 9-12. Typical Slow-Close test report

9.19 Transducer Self-Test

The users can check transducer electronics by connecting transducer to the CT-7500 and running a "Transducer Self Test".

Table 9-20. Performing a Transducer Self Test

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. PRINT DATA 3. TEST TRANSDUCER 4. CHECK HOOKUP
2	SELECT TRANSDUCER.	PRESS # 3 KEY.	TRANSDUCER TEST 1= XXX.XX INCHES 2= XXX.XX INCHES 3= XXX.XX INCHES

Note

1. After selecting transducer test mode, move transducer slider and observe display on the CT-7500 LCD.

2. If slider is moved 1.00", the CT-7500 LCD should display 1.00".

3. Press STOP key to return to main menu.

9.20 Check Cable Hookup

Table 9-21. Checking the Cable Hookup

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. PRINT DATA 3. TEST TRANSDUCER 4. CHECK HOOKUP
2	SELECT CHECK HOOK UP.	PRESS # 3 KEY.	MAKE SURE BREAKER IS IN CLOSE POSITION, THEN PRESS "START"
3	INITIATE TEST.	PRESS "START" KEY.	1 2 3 4 5 6 C - - - - - 7 8 9 10 11 12 - - - - - -
4	RETURN TO MAIN MENU.	PRESS "STOP" KEY.	1. TIME BREAKER 2. GET RESULT 3. SET UP 4. DIAGNOSTIC

Notes

1. The CT-7500 will also print the test report with the thermal printer.

2. A contact closure is shown as "C" on the LCD and printout.

3. An open contact is shown as "-" on the LCD and printout.

9-21 Automatic Print Setting

The CT-7500 can be set to print graph and tabulated results automatically after timing a breaker. To turn on “Auto Print Results” mode, follows steps in table below

Table 9-22. Automatic Print Setting

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. COMPUTER IF 4. CLOCK 5.PRINT
3	SELECT SET PRINT.	PRESS # 5 KEY.	SET PRINT MODE 1. AUTOMATIC PRINT 2. BY REQUEST ONLY
4	SELECT “AUTOMATIC PRINT”.	PRESS # 1 KEY.	1. TIME BREAKER 2. GET RESULT 3. SET UP 4. DIAGNOSTIC

Note

Select print “BY REQUEST ONLY” will disable Automatic Print mode.

10.0 Running CT-7500s in Tandem

For timing application requiring more than 12 timing contact channels, the user can use two or more CT-7500s to time a circuit breaker. A typical application is to use a CT-7500-12 and a CT-7500-6 to time a 18 contact ATB. To time this circuit breaker, the user can use the following steps:

Connect the CT-7500-12 to phase A and B of the circuit breaker.
Connect the CT-7500-6 to phase C on the circuit breaker.
Connect the CT-7500-12 initiate cable to the breaker control circuit. The **CT-7500-12** will **operate** the circuit breaker.
Connect the external trigger cable of the CT-7500-6 to the OPEN coil for the OPEN test or CLOSE coil for the CLOSE test. The **CT-7500-6** will **operate as the slave device**.
Set the CT-7500-6 to start a test using **"External Trigger".**
Set the CT-7500-12 to start a test using **"Internal Trigger".**
Press the "START" key on the CT-7500-6 to start the sequence then press the "START" key and hold the "ARM" switch on the CT-7500-12.

The CT-7500-12 will operate the circuit breaker and start the timing sequence; The CT-7500-6 will start its timing sequence as soon as it senses the voltage applied to the breaker coil.
The timing report of the CT-7500-12 will show the contact time for phase A and B. The timing report of the CT-7500-6 shows contact time for phase C.
If the user down-loads the test results of both the CT-7500s to the PC, the user then can combine the 2 test reports to generate a 18 channel test report.

11.0 CT-7500 Trouble Shooting Guide

Problems	Suggestion
1. CT-7500 will not trip or close breaker.	■ Make sure you hold the "ARM" switch down during test. ■ Check OPEN or CLOSE fuses. ■ Check initiate leads. For a "Positive Trip" circuit, one Close lead and one Open lead should be connected to the Positive of the power supply. ■ Check initiate leads. For a "Negative Trip" circuit, one Close lead and one Open lead should be connected to the Negative of the power supply.
2. No contact time (0 ms) in Trip or Close test.	■ Make sure one side of breaker in not grounded. ■ Make sure the breaker operates on OPEN or Close test only. A dual operation OPEN-CLOSE or CLOSE-OPEN will resulting in 0ms reading. ■ Bad CT-7500 contact channels or bad cables. Try "CHECK HOOK-UP" test.
3. No contact time (0 ms) in Close-Open.	■ Make sure breaker contacts complete the transition from Open (initial state) to Close then Open (final state). You can see this transition by looking at the timing chart. ■ Make sure the contact close state is longer than 10ms. The CT-7500 has a 10ms de-bounce time, any contact state less than or equal to 10ms is invalid. If you have this problem, your delay time is probably too slow. ■ Try Close-Open using contact channel #1 option.
4. Select Open-Close test. The breaker opens and will not close.	■ Delay between Open to Close is probably too small. Increase delay time.
5. No tabulated and timing chart for contact channels above #3.	■ The CT-7500 always defaults to contact channels 1,2 and 3. You need to turn on contact channels above 3.
6. No tabulated or timing chart for travel 2 and 3.	■ Turn on travel channel 2 and 3.
7. No data or erratic reading on travel transducer.	■ Bad transducer. Try "TRANSDUCER" test. ■ Transducer slider is not secured to timing rod. ■ Transducer is not secured properly.
8. No activity on V2 voltage input channel.	■ The V2 voltage input channel requires a voltage change (0v to above 30v) to see activities on the timing chart.

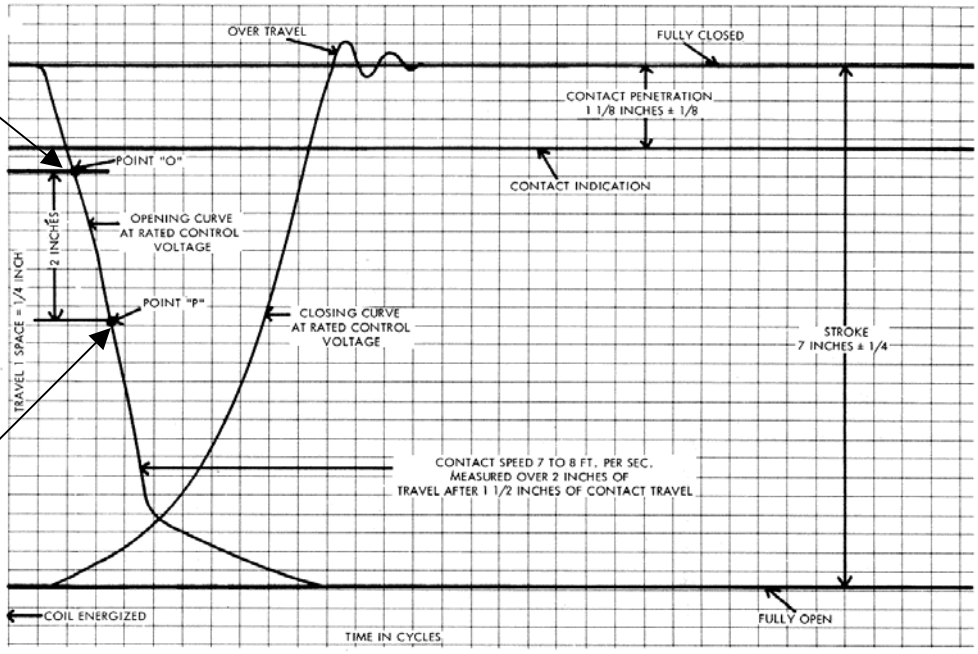
Problems	Suggestion
9. No "PASS/FAIL" on tabulated report.	■ Test plan is not loaded before taking test. You can load test plan then re-print the tabulated report.
10. CT-7500 will not communicate with PC.	■ Make sure CT-7500 is under computer control. ■ Make sure your PC com port is selected correctly. ■ Make sure your serial cable is connected properly.
11. Turn on Automatic Print Results mode.	■ See section 9-21.
12. CT-7500 will not print results on external printer.	■ The CT-7500 will support HP ink-jet printer only. ■ Check your printer cable.
13. Where can I get some thermal paper?	■ Call the factory at 909-923-9390 or BG Instruments at 509-893-9881. The CT-7500 uses TP-4 thermal paper. ■ In case of an emergency, you can get thermal paper from Radio Shack. Radio Shack carries 4.25" wide thermal paper. It is not the right size but it will work.
14. How do I darken or lighten the LCD?	■ Press and hold the "↑ PAPER LCD" key for 3 seconds will darken LCD. ■ Press and hold the "↓ PAPER LCD" key for 3 seconds will lighten LCD.
15. How do I move thermal paper forward or backward?	■ Press and release the "↑ PAPER LCD" key will advance thermal paper. ■ Press and release the "↓ PAPER LCD" key will move thermal paper backward.

APPENDIX A

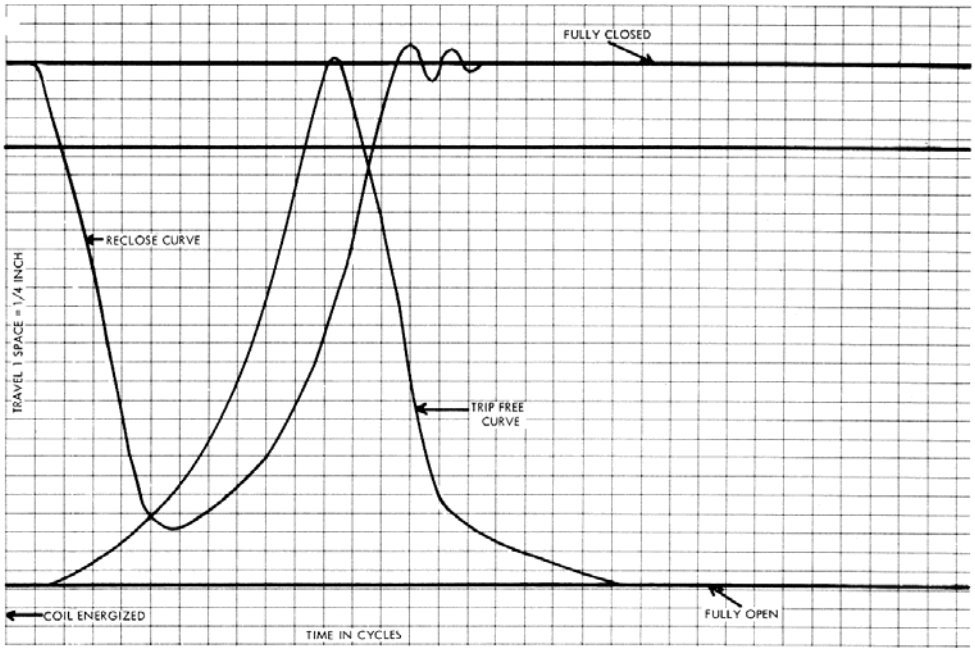
ITE Circuit Breaker model 14.4K Timing Chart.

AP1= 1.5”

AP2= 3.5”



TYPICAL NO LOAD TRAVEL CURVES FOR OPENING AND CLOSING OPERATIONS
AT RATED CONTROL VOLTAGE



TYPICAL NO LOAD TRAVEL CURVES FOR RECLOSING AND TRIP-FREE OPERATIONS
AT RATED CONTROL VOLTAGE

APPENDIX B

CT-7500 Test Plan for ITE Circuit Breaker Model 14.4K.

TEST PLAN NUMBER 1

MFR: 14.4KS500-20B
TYPE: ITE
COMMENT:

CONTACT TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	035.0	180.0
MIN <mS>	030.0	170.0
DELTA LIM <mS>	006.0	008.0

RESISTOR TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	999.0	999.0
MIN <mS>	000.0	000.0
DELTA LIM <mS>	010.0	010.0

TRAVEL PARAMETERS

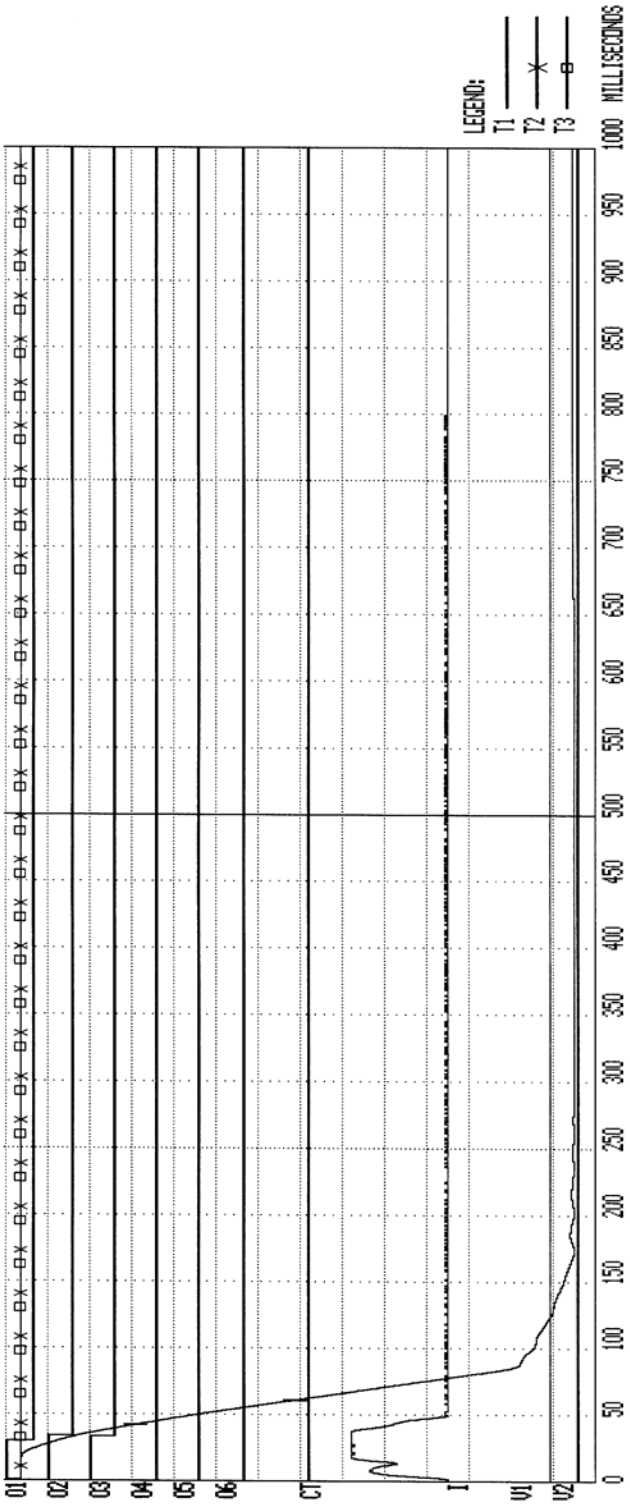
	STRK in	VEL ft/S	O-TVL in	BNC-BK in
OPEN HI	07.25	43.64	00.20	00.20
OPEN LOW	06.75	00.00	00.00	00.00
CLOSE HI	07.25	07.00	00.40	00.25
CLOSE LO	06.75	04.50	00.00	00.00

OPEN SPEED ANALYSIS POINTS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

CLOSE SPEED ANALYSIS POINTS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

APPENDIX C

CT-7500 Timing Chart for ITE Circuit Breaker Model 14.4K.



APPENDIX D

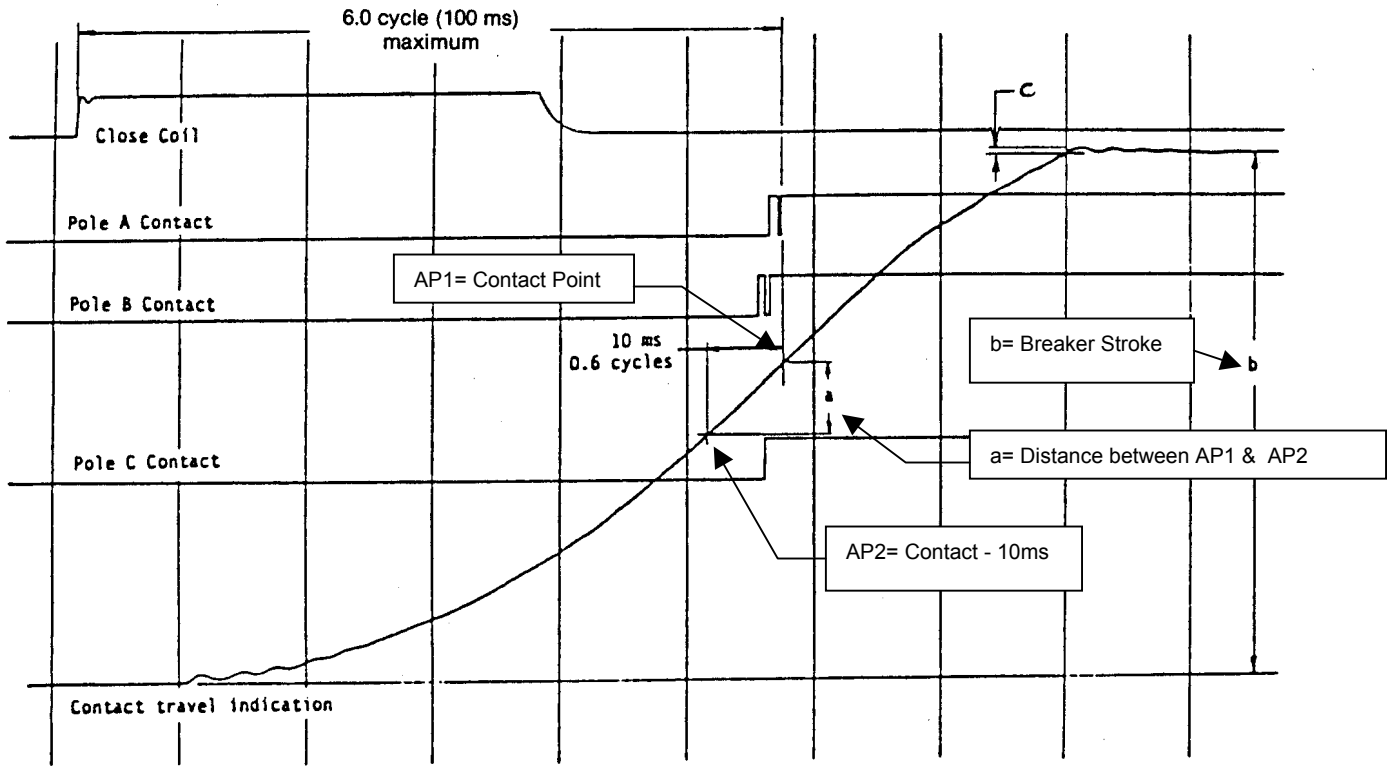
CT-7500 Tabulated Report for ITE Circuit Breaker Model 14.4K.

```
BREAKER TIMING RESULTS - 60 Hz

          SHOT NUMBER: 0007
DATE:  12/22/00    TIME:  10:35:03

COMPANY:   VANGUARD INSTRUMENT
STATION:   ONTARIO
CIRCUIT:
MFR:       ITE
MODEL:     14.4KS500-20B
S/N:       12345
OPERATOR:  HAI

TEST:  OPEN

CONTACT TIME
CH   TIME   CYCLE  P/F   BOUNCE   WIPE
     <mS>                <mS>     <in>
 1  029.50  01.77  FAIL  000.20  00.49
 2  033.10  01.99  PASS  000.20  00.72
 3  033.00  01.98  PASS  000.30  00.71
 4  000.00  00.00  FAIL  000.00  00.00
 5  000.00  00.00  FAIL  000.00  00.00
 6  000.00  00.00  FAIL  000.00  00.00
DELTA TIME <mS>:  003.60 PASS

TRAVEL ANALYSIS   T1    P/F
STROKE        in   07.00 PASS
SPEED      ft/S    09.11 PASS
OVER-TRAVEL  in   00.02 PASS
BOUNCE BACK  in   00.00 PASS

TRAVEL ANALYSIS   T2    P/F
STROKE        in   00.00 FAIL
SPEED      ft/S    00.00 PASS
OVER-TRAVEL  in   00.00 PASS
BOUNCE BACK  in   00.00 PASS

TRAVEL ANALYSIS   T3    P/F
STROKE        in   00.00 FAIL
SPEED      ft/S    00.00 PASS
OVER-TRAVEL  in   00.00 PASS
BOUNCE BACK  in   00.00 PASS

SPEED ANALYSIS:
POINT 1 = 01.50 in
POINT 2 = 03.50 in

V1 NOMINAL VOLTAGE = 0 VOLTS
V1 MINIMUM VOLTAGE = 0 VOLTS
INITIATOR CURRENT  = 05.2 AMPS

SHOT LENGTH:              1 SECOND
INSERTION RESISTOR:       NO
TRIGGER:                  INTERNAL

VANGUARD INSTRUMENT CO., HPN (C) 1998.99.2000
1710 GREVILLEA CT. ONTARIO. CA 91761. USA
TEL (909)923-9390 FAX (909)923-9391
REV: 1.312
OPERATION: 0009
SERIAL NUMBER: 75035
CLOSE THRESHOLD = 020  OPEN THRESHOLD = 200  CT THRES = 255
SAMPLE = 011  VOLTAGE = 064
```

CT-7500 Timing Chart for ITE Circuit Breaker Model

APPENDIX E

Timing Chart for Siemens TCP-149 Circuit Breaker.



Sample Travel Analyzer Record
For a Closing Operation

Example of Close Operation Record

Calculation For Contact Closing Velocity =

$$V = 31.5 \frac{a}{b} \text{ meter/second}$$

Calculation For overtravel/rebound

$$S = 31.5 \frac{c}{b} \text{ meter/second}$$

Note: a, b, and c may be measured in any consistant units

Note

Velocity calculation for this breaker requires a formula:

V= 31.5 x (a/b) m/s

APPENDIX F

CT-7500 Test Plan for Siemens TCP-149 Circuit Breaker.

TEST PLAN NUMBER 2

MFR: TCP-121
TYPE: SIEMENS
COMMENT:

CONTACT TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	032.0	100.0
MIN <mS>	029.0	090.0
DELTA LIM <mS>	005.0	005.0

RESISTOR TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	999.0	999.0
MIN <mS>	000.0	000.0
DELTA LIM <mS>	010.0	010.0

TRAVEL PARAMETERS

	STRK in	VEL ft/S	O-TVL in	BNC-BK in
OPEN HI	02.17	27.88	00.12	00.12
OPEN LOW	01.97	21.32	00.00	00.00
CLOSE HI	02.17	16.40	00.20	00.20
CLOSE LO	01.97	12.46	00.00	00.00

VEL = C x [DIST<AP1 - AP2>/STROKE]
C = 31.50 M/S

OPEN SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT PLUS 010.0 mS

CLOSE SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT MINUS 010.0 mS

Note

Formula to calculate velocity is programmed in breaker test plan.

Vanguard Instruments Company, Inc.

www.vanguard-instruments.com